THE

POPULAR SCIENCE MONTHLY.

AUGUST, 1877.

THE CLIMATIC INFLUENCE OF VEGETATION.—A PLEA FOR OUR FORESTS.

By F. L. OSWALD, M. D.

"AS a fellow-Unitarian, I feel sorry for the Turks," Dr. Schliemann writes from Salonica, "but, as a respecter of God's physical laws, I must own that they deserve their fate. Men who for twenty generations have proved themselves tree-destroyers on principle, have no right to complain if the world rises against them."

It would be well for the world if for the last twenty generations the Turks had been the only "tree-destroyers on principle." Since the advent of the Christian religion, the physical history of our planet records the steady growth of a desert, which made its first appearance on the dry table-land of Southern Syria, and gradually spreading eastward down the Euphrates toward Afghanistan, and westward along both shores of the Mediterranean, now extends from Eastern Persia to the western extremity of Portugal, and sends its harbingers into Southern France and the southeastern provinces of European Russia. Like a virulent cancer, the azoic sand-drifts of the Moab Desert have eaten their way into Southern Europe and Northern Africa, and dried up the life-springs of districts which beyond all dispute were once the garden-regions of this earth.

Prince de Ligne, countryman and contemporary of Maria Theresa, wrote an essay "On the Location of the Earthly Paradise," and, after some reflections on the hygienic influence of different climates, calls attention to the fact that "paradise-traditions, in locating the garden of Eden, differ only in regard to longitude, but not to latitude. The latitude keeps always near the *snow-boundary*, a line just south of the regions where snow may fall, but will not stay on the ground. It passes through Thibet, Cashmere, Northern Persia, and Asia Minor,

and reaches the meridian of Europe near the centre of the Mediterranean." The nations that "celebrated life as a festival" have lived along this line, and we may doubt if in the most favored regions of the New World human industry, with all the aids of modern science, will ever reunite the opportunities of happiness which Nature once lavished on lands that now entail only misery on their cultivators. All over Spain and Portugal, Southern Italy, Greece, Turkey, Asia Minor, Persia, and Western Afghanistan, and throughout Northern Africa, from Morocco to the valley of the Nile, the aridity of the soil makes the struggle for existence so hard that to the vast majority of the inhabitants life from a blessing has been converted into a curse.

Southern Spain, from Gibraltar to the head-waters of the Tagus, maintains now only about one-tenth of its former population, Greece about one-twentieth. As late as A. D. 670, a good while after the rise of the Mohammedan power, the country now known as Tripoli, and distinct from the Sahara only through the elevation of its mountains, was the seat of eighty-five Christian bishops, and had a population of 6,000,000, of which number three-quarters of one per cent. are now left! The climate which, according to authentic description, must once have resembled that of our Southern Alleghanies, is now so nearly intolerable that even the inhumanity of an African despot forbears to exact open-air labor from 9 A. M. to 5 P. M. Steamboats that pass near the Tripolitan coast in summer, on their way from Genoa to Cairo, have to keep up a continual shower of artificial rain to save their deck-hands from being overcome by the furnace-air that breathes from the barren hills of the opposite coast. The rivers of some of these countries have shrunk to the size of their former tributaries, and from Gibraltar to Samarcand the annual rainfall has decreased till failure of crops has become a chronic complaint.

And all this change is due to the insane destruction of forests. The great Caucasian *sylvania* that once adorned the birth-land of the white race from the Western Pyrenees to the foot-hills of the Himalayas has disappeared; of the forest-area of Italy and Spain, in the days of the elder Pliny, about two acres in a hundred are left; in Greece, hardly one. But even the nakedness of the most sterile tracts of Southern Europe is exceeded by the utter desolation of the Ottoman provinces. If there was not evidence that a great part of the ruin had been accomplished before the fall of the Byzantine Empire, the Turks would really seem to have been "tree-destroyers on principle." In the recesses of the Taurus range and the inaccessible heights of those

> ". . . . mountains that distill
> Indus and Oxus from their icy caves"—

a few remnants of wood have survived the general devastation, but throughout the lowlands, from Bokhara to the Golden Horn, not a stick or bush can grow up before the wood-famine of the wretched

population lays violent hands upon it. In Northern Africa, Dalmatia, and the larger islands of the Grecian Archipelago, the same evil has made terrible advances. The Mediterranean Sea, once a forest-lake of paradise, is now a dead sea, surrounded by dusty and burning coasts, often for hundreds of miles without a vestige of organic life.

The present appearance of the Troad, the neighborhood of Lake Tiberias, the valley of the Euphrates, and other districts that were once teeming with population, can actually make us doubt if there ever was such a thing as an original desert. On the plateau of Sidi-Belbez, in the very centre of the Sahara, Champollion traced the course of former rivers and creeks by the depressions in the soil and the shape of the smooth-washed pebbles. He also found tree-stumps, now almost petrified, and covered by a six-foot stratum of burning sand.

"And so the astounding truth dawns upon us," he says, "that this desert may once have been a region of groves and fountains, and the abode of happy millions. Is there any crime against Nature which draws down a more terrible curse than that of stripping our Mother Earth of her sylvan covering? The hand of *man* has produced this desert, and I verily believe every other desert on the surface of this earth. Earth was Eden once, and our misery is the punishment of our sins against the world of plants. *The burning sun of the desert is the angel with the flaming sword who stands between us and paradise.*"

That the inhabitants of these artificial deserts have failed to recognize the cause of their misery implies a degree of infatuation and mental blindness which may appear even more incredible to future generations than the thousand years' belief in witchcraft and the patient submission of 80,000,000 able-bodied men to a juggler-guild of priests. Even frogs and fishes become uneasy if the plug-hole of their tank is opened and their life-element begins to ebb away; and it should be supposed that, without any scientific aids to reflection, the sheer instinct of self-preservation could have suggested the simple remedy before the evil attained its present proportions.

But this blindness of the Latin races and the devotees of Islam, if not justified, is at least partly explained by the fatalism of their religion. Their belief in supernatural agencies, and a meddlesome Providence that ruled the world *in spite of man*, naturally produced indifference to all physical sciences whatever. The three Semitic religions have done more to divorce man from Nature than all his inborn vices and the "necessary decay of civilized races" that is so often preferred as an explanation. "Though our mortal eyes have failed to penetrate the depths of heaven," says Erasmus, "we have succeeded in losing sight of our own earth." If this earth was a vale of tears, and heaven our proper home, all attention to earthly affairs seemed so much lost time, and in the souls of men who were taught to consider their natural feelings as antagonistic to the will of God the warning voice of instinct was raised in vain.

Much more unaccountable seems our own indifference to the disappearance of our forests, since our science has demonstrated to the satisfaction of all rational and semi-rational beings—including some very conservative rulers of Western Europe—that an animal flayed, or a tree stripped of its bark, does not perish more surely than a land deprived of its trees.

The Duke of Burgundy's rule, "One-third to the hunter, two-thirds to the husbandman," expresses about the most desirable proportion of woodlands and cultivated fields. In a country blessed with such a plethora of woods as the United States between the Atlantic and the valley of the Mississippi could boast of less than a hundred years ago, the work of "clearing" could therefore be pursued within very liberal limits, not only without injury, but with positive benefit to the climate, inasmuch as it would counteract excess of moisture and miasmatic tendencies. But in some of our Southern and Central States this limit has already been passed. The States of Ohio and Indiana, and the southern parts of Kentucky and Michigan, so recently a part of the great East-American forest, have even now a greater percentage of treeless area than Austria and the North-German Empire, that have been settled and cultivated for upward of a thousand years. The northern borders of Ohio are kept comparatively fertile by the neighborhood of the great lakes, but the central regions, and many of the river-counties, begin to suffer from drought, and see their springs fail in every summer. The "Blue-Grass" region of Kentucky, once the pride of the West, has now districts of such a barren and arid nature that their stock-farmers are moving toward the Cumberland Mountains, because the creeks and old springs dried up, and their wells became too low to furnish water for their cattle.

Wherever tobacco and cotton are cultivated, the work of ruin has made rapid advances, and in all the southeastern counties of Virginia and North Carolina, and throughout Mississippi, Alabama, Georgia, and South Carolina, the traveler may ride for hours without seeing more than four or five trees in a group; droughts are becoming more and more frequent, and the locust, that ominous pioneer of the desert, has made its appearance.

The climatic influence of arboreal vegetation must be more generally understood, before such legislative measures as the importance of the subject demands, can be hoped for. In the economy of Nature forests perform innumerable functions which no artificial contrivance can imitate, and of which the following are only the most important:

Woods, in the first place, are the water-reservoirs of Nature, and hold in the network of their roots and their moss-carpet the moisture which is intended to supply our water-courses in the season of midsummer heat. One acre of full-grown beech-trees absorbs and dispenses as much humidity as twenty acres of grape-vines and tobacco, and more than two hundred acres of cereals.

Forests *produce* rain. Under the influence of vertical sun-rays trees exhale the aqueous vapors which their leaves have absorbed from the atmosphere, and in contact with the night-air or any stray current of lower temperature, these vapors discharge rain-showers even in mid-summer, and at a great distance from the sea.

By moistening the air woodlands also moderate the extremes of heat and cold. It is seen on the sea-shore how beneficently humidity operates in allaying the severity of winter, and in summer the evaporation of dew and rain gives us cool breezes when they are most needed. By the extirpation of forests the climate of the entire *Orbis Romanus* has been changed from the summer temperature of West Virginia to the furnace-heat of New Mexico and Arizona.

Besides this, the forest by shade in summer and fuel in winter protects us directly against the vicissitudes of temperature, and at the foot of high mountains interposes a mechanical barrier between the valleys and avalanches in the north, and floods in the south. The water-torrents, which not only flood and damage the lowlands, but carry their fertile soil away, are imbibed or detained by extensive forests. Joseph II. of Austria was right to attach heavy penalties to the destruction of the "Bannwälder," the woods on the Alpine slopes, that protect the valleys from avalanches, and to propose that in wars, even *à l'outrance*, the trees of a country should be spared by international agreement.

Our woods are also the home and shelter of those best friends of man, the insectivorous birds. A country destitute of trees is avoided by birds, and left to the ravages of locusts and other insects, which, as we saw on our own continent, always attack the barren and naked districts. Our locust-swarms devastated the "Great West," i. e., the treeless expanse between the Mississippi and the Rocky Mountains, but spared the woodlands of the Alleghanies and the timber-regions of the Pacific slope.

The exhilarating influence of a woodland excursion is not altogether due to scenic effects and imagination. Forests exhale oxygen, the life-air of flames and animal lungs, and absorb or neutralize a variety of noxious gases. Scirrhous affections of the skin and other diseases disappear under the disinfecting influence of forest-air. Dr. Brehm observes that ophthalmia and leprosy, which have become hereditary diseases, not only in the valley of the Nile, but also on the table-lands of Barca and Tripoli, are utterly unknown in the well-timbered valley of Abyssinia, though the Abyssinians live more than a hundred geographical miles *nearer* to the equator than their afflicted neighbors.

The traditions of the "blessed islands of the West," the "Garden of the Hesperides," probably referred to Madeira and the Cape-Verde Archipelago, which, according to De Gama's description, must have come nearer to our idea of terrestrial paradise than any other region

of this earth. "The ills that flesh here is heir to," he says, "are only three: wounds, the effects of poison, and decrepitude—the latter rarely makes its appearance before the completion of the ninetieth year." Since the Portuguese have felled their glorious forests for the sake of *madeira* (building-material), these islands have become hot-beds of disease.

The valley of the Guadalquivir, as late as a century before the discovery of America, supported a population of 7,000,000 of probably the healthiest and happiest men of Southern Europe. Since the live-oak and chestnut groves of the surrounding heights have disappeared this population has shrunk to a million and a quarter of sickly wretches, who depend for their sustenance on the scant produce of sandy barrens that become sandier and drier from year to year.

It would be exaggeration to say that the barrenness of a treeless country is an evil without remedy. Nature is always ready to assist in any work of regeneration, and there is no desert so void and naked that it might not be reclaimed in the course of half a century. The Khédive of Egypt has wrested land from the sand-wastes as the Hollanders win it from the sea, and by a cheaper process than the building of extensive dikes. By planting date-palms and olive-trees, Egypt has added many hundred square miles to her arable surface, and, as Baker-Pasha assures us, her *annual rainfall* has almost doubled. Between Karnak and Soodan the rain-gauge shows now a yearly average of sixteen inches, where nine inches was the maximum before 1820. And not only the limits of these tree-plantations, but also the adjoining districts, have been benefited; on the table-land of Wady-Halfa the present temperature is not nearly as oppressive as it was within the memory of men now living, and currant-bushes and wild-mulberries have sprung up where they never grew before. In France, too, the Government has reclaimed the *Landes*, a sandy steppe on the southwestern coast, by planting willows and bay-trees; and even Algeria has been improved by the persistent tree-culture of the French colonists.

But how slow and laborious is this work of restoration, and how easily might we forestall its necessity if we would begin in time! A legislative act to protect the woods of all the upper ridges in hill-countries, and of a certain percentage of acres, say fifteen in a hundred, in the plains, would be an effectual guarantee against evils which otherwise will assuredly overtake us, and speedier than Europe, on account of the compact shape of our continent, that deprives us of the advantages of a marine climate.

Let us remember that the aphorism of the greatest physician of modern times applies to other organisms as well as to the human body. "Timely prevention," said Dr. Radcliffe, "not only saves us from diseases, but from those greater evils—*the remedies*."

EDUCATION AS A SCIENCE.

By ALEXANDER BAIN, LL. D.,
PROFESSOR IN THE UNIVERSITY OF ABERDEEN.

III.

IN preceding articles,[1] the psychological bearings of Education were entered upon; and two out of the three primary functions of the intellect were considered. There remained the power named—

Similarity or Agreement.—It is neither an inapt nor a strained comparison to call this power the law of gravitation of the intellectual world. As regards education, it has an importance coequal with the plastic force that is expressed by retentiveness or memory. The methods to be pursued in attaining the commanding heights of general knowledge are framed by the circumstances attending the detection of like in the midst of unlike.

With all the variety that there is in the world of our experience, a variety appealing to our consciousness of difference, there is also great repetition, sameness, or unity. There are many shades of color, as distinguished by the discriminative sensibility of the eye; yet the same shade often recurs. There are many varieties of form—the round, the square, the spiral, etc.—and we discriminate them when they are contrasted; while the same form starts up again and again. At first sight, this would appear to mean nothing at all; the great matter would appear to be to avoid confounding differences—blue with violet, a circle with an oval; when blue recurs, we simply treat it as we did at first.

The remark is too hasty, and overlooks a vital consideration. What raises the principle of similarity to its commanding height is the accompaniment of *diversity*. The round form first discerned in a ring or halfpenny recurs in the full moon, where the adjuncts are totally different and need to be felt as different. In spite of these disturbing accompaniments, it is important to feel the agreement on the single circumstance called the round form.

When an impression made in one situation is repeated in an altered situation, the new experience reminds us of the old, notwithstanding the diversity; this reminder may be described as a new kind of shock, or awakened consciousness, called the shock or flash of identity in the midst of difference. A piece of coal and a piece of wood differ, and are at first looked upon as differing. Put into the fire, they both blaze up, give heat, and are consumed: here is a shock of agreement which becomes an abiding impression in connection with

[1] *See* Popular Science Monthly for February and March, 1877.

these two things. Of such shocks is made up one-half of what we term knowledge.

Whenever there is a difference it should be felt by us; and so wherever there is an agreement it should be felt. To overlook either the one or the other is stupidity of mind. Our education marches in both lines; and, in so far as we are helped by the schoolmaster, we should be helped in both. The artifices that promote discrimination, and the influences that thwart it, have been already considered; and many of the observations apply also to agreement. In the identifying of like in the midst of unlike, there are cases that are easy; and there are cases that the unassisted mind fails to perceive.

1. We must repeat, with reference to the delicate perception of Agreements, the antithesis of the intellectual and the emotional outgoings. It is in the stillness of the emotions that the higher intellectual exercises are possible. This circumstance should operate as a warning against the too frequent recourse to pains and penalties, as well as against pleasurable and other excitement. But a more specific application remains.

We may at once face the problem of general knowledge. The most troublesome half of the education of the intellect is the getting possession of generalities. A general fact, notion, or truth, is a fact recurring under various circumstances or accompaniments: "heat" is the name for such a generality; there are many individual facts greatly differing among themselves, but all agreeing in the impression called heat—the sun, a fire, a lamp, a living animal. The intellect discerns, or is struck with, the agreement, notwithstanding the differences; and in this discernment arrives at a general idea.

Now the grand stumbling-block in the way of the generalizing impetus is the presence of the individual differences. These may be small and insignificant; in comparing fires with one another, the agreement is striking, while the differences between one fire and another, in size, or intensity, or fuel, do not divert the attention from their agreement. But the discerning of sameness in the sun's ray and in a fermenting dung-heap is thwarted by the extraordinary disparity; and this conflict between the sameness and the difference operates widely and retards the discovery of the most important truths.

2. The device of *juxtaposition* applies to the expounding of agreement, no less than of difference. We can arrange the several agreeing facts in such a way that the agreement is more easily seen. The effect is gained partly by closeness, as in the case of differences, and partly by a symmetrical contact, as when we compare the two hands by placing them finger to finger, and thumb to thumb. Such symmetrical comparisons bring to view, in the same act, agreement and difference. The method reaches far and wide, and is one of the most powerful artificial aids to the imparting knowledge.

3. The *cumulation* of the instances is essential to the driving home of a generality. A continuous, undistracted iteration of the point of agreement is the only way to produce an adequate impression of a great general idea. I cannot now consider the various obstacles encountered in this attempt, nor explain how seldom it can be adhered to in the highest examples. It must suffice to remark that the interest special to the individual examples is perpetually carrying off the attention; and pupil and master are both liable to be turned aside by the seduction.

There is another aspect of the power of similarity, under which it is a valuable aid to memory or retention. When we have to learn an exercise absolutely new, we must ingrain every step by the plastic adhesiveness of the brain, and must give time and opportunity for the adhesive links to be matured. But when we come to an exercise containing parts already acquired by the plastic operation, we are saved the labor of forging fresh links as regards these, and need only to master what is new to us. When we have known all about one plant, we can easily learn the other plants of the same species or genus; we need only to master the points of variety.

The bearing of this circumstance on mental growth must be apparent at once. After a certain number of acquirements in the various regions of study—manual art, language, visible pictures—nothing that occurs is absolutely new; the amount of novel matter is continually decreasing as our knowledge increases. Our adhesive faculty is not improving as we grow in years; very much the contrary: but our facility in taking in new knowledge improves steadily; the fact being that the knowledge is so little new that the forging of fresh adhesions is reduced to a very limited compass. The most original air of music that the most original genius could compose would be very soon learned by an instructed musician.

In the practice of the schoolmaster's art, this great fact will be perpetually manifesting itself. The operation can be aided and guided in those cases where the agreement really existing is not felt. It is one of the teaching arts to make the pupils see the old in the new, as far as the agreement reaches; and to pose them upon this very circumstance. The obstacles are the very same as already described, and the means of overcoming them the same. Orderly juxtaposition is requsite for matters of complexity; and we may have also to counterwork the attractions of individuality.

Constructiveness.—In many parts of our education, the stress lies not in simple memory, or the tenacious holding of what has been presented to the mind, but in making us perform some new operation, something that we were previously unable to do. Such are the first stages of our instruction in speaking, in writing, and in all the mechanical or manual arts. So also in the higher intellectual processes, as in the imagining of what we have not seen. I do not go so far as

to include invention or discovery; the culture of the creative faculty is not comprised in the present discussion.

The psychology of constructiveness is remarkably simple. There are certain primary conditions that run through all the cases; and it is by paying due respect to these conditions that we can, as teachers, render every possible assistance to the struggling pupils.

1. The constructive process supposes *something to construct from;* some powers already possessed that can be exercised, directed, and combined, in a new manner. We must walk before beginning to dance; we must articulate simple sounds before we can articulate words; we must draw straight strokes and pot-hooks before we can form letters; we must conceive trees and shrubs, flowers and grassy plots, before we can conceive a garden.

The practical inference is no less obvious and irresistible; it is one that covers the whole field of education, and could never be entirely neglected, although it has certainly never been fully carried out. Before entering on a new exercise, we must first be led up to it by mastering the preliminary or preparatory exercises. Teachers are compelled by their failures to attend to this fact in the more palpable exercises, as speaking and writing. They lose sight of it, when the succession of stages is too subtile for their apprehension, as in the understanding of scientific doctrines.

2. In aiming at a new construction, *we must clearly conceive what is aimed at;* we must have the means of judging whether or not our tentatives are successful. The child in writing has the copy-lines before it; the man in the ranks sees the fugleman, or hears the approving or disapproving voice of the drill-sergeant. Where we have a very distinct and intelligible model before us, we are in a fair way to succeed; in proportion as the ideal is dim and wavering, we stagger and miscarry. When we depend upon a teacher's expressed approval of our effort, it behooves him to be very consistent, as well as very sound, in his judgment; should he be one thing to-day, and another thing to-morrow, we are unhinged and undone.

It is a defect pertaining to all models that they contain individual peculiarities mixed up with the ideal intention. We carry away with us from every instructor touches of mannerism, and the worst of it is that some learners catch nothing but the mannerism; this being generally easier to fall into than the essential merits of the teaching. There is no remedy here except the comparison of several good models; as the ship-captain carries with him a number of chronometers.

In following an unapproachable original, as in learning to write from copperplate lines, we need a second judgment to inform us whether our deviations are serious and fundamental, or are venial and unavoidable. The good tact of our instructor is here put to the test; he may make our path like the shining light that shineth more and more, or he may leave us in hopeless perplexity. To point out to us

where, how, and why, we are wrong, is the teacher's most indispensable function.

3. The only mode of arriving at a new constructive combination is *to try and try again.* The will initiates some movements; these are found not to answer, and are suppressed; others are tried, and so on, until the requisite combination has been struck out. The way to new powers is by trial and error. According as the first and second conditions above given are realized, the unsuccessful trials are fewer. If we have been well led up to the combination required, and if we have before us a very clear idea of what is to be done, we do not need many tentatives; the prompt suppression of the wrong movements ultimately lands us in the right.

The mastering of a new manual combination—as in writing, in learning to swim, in the mechanical arts—is a very trying moment to the human powers; success involves all those favorable circumstances indicated in discussing the retentive or receptive faculty. Vigor, freshness, freedom from distraction, no strong or extraneous emotions, motives to succeed—are all most desirable in realizing a difficult combination. Fatigue, fear, flurry, or other wasting excitement, does away with the chances of success.

Very often we have to give up the attempt for a time; yet the ineffectual struggles are not entirely lost. We have at least learned to avoid a certain number of positions, and have narrowed the round of tentatives for the next occasion. If, after two or three repetitions, with rest-intervals, the desired combination does not emerge, it is a proof that some preparatory movement is wanting, and we should be made to retrace the approaches. Perhaps we may have learned the prerequisite movements in a way, but not with sufficient firmness and certainty for securing their being performed in combination.

ALTERNATION AND REMISSION OF ACTIVITY.—In the accustomed routine of education, a number of separate studies and acquirements are prosecuted together; so that, for each day, a pupil may have to engage in as many as three, four, or more, different kinds of lessons.

The principles that guide the alternation and remission of our modes of exercise and application are apparently these:

1. Sleep is the only entire and absolute cessation of the mental and bodily expenditure; and perfect or dreamless sleep is the greatest cessation of all. Whatever shortens the due allowance of sleep, renders it fitful and disturbed, or promotes dreaming, is so much force wasted.

In the waking hours, there may be cessation from a given exercise, with more or less of inaction over the whole system. The greatest diversion of the working forces is made by our meals; during these the trains of thought are changed, while the body is rested.

Bodily or muscular exercise, when alternated with sedentary mental labor, is really a mode of remission accompanied with an expenditure requisite to redress the balance of the physical functions. The

blood has unduly flowed to the brain; muscular exercise draws it off. The oxidation of the tissues has been retarded; muscular exercise is the most direct mode of increasing it. But definite observations teach us that these two beneficial effects are arrested at the fatigue-point; so that the exercise at last contributes not to the refreshment, but to the further exhaustion of the system.

2. The real point before us is, What do we gain by dropping one form of activity and taking up another? This involves a variety of considerations.

It is clear that the first exercise must not have been pushed so far as to induce general exhaustion. The raw recruit, at the end of his morning drill, is not in a good state to improve his arithmetic in the military schoolroom. The musical training for the stage is at times so severe as to preclude every other study. The importance of a particular training may be such that we desire for it the whole available plasticity of the system.

It is only another form of exhaustion when the currents of the brain continue in their set channels and refuse any proposed diversion.

There are certain stages in every new and difficult study, wherein it might be well to concentrate for a time the highest energy of the day. Generally, it is at the commencement; but whatever be the point of special difficulty, there might be a remission of all other serious or arduous studies, till this is got over. Not that we need actually to lay aside everything else; but there are, in most studies, many long tracts where we seem in point of form to be moving on, but are really repeating substantially the same familiar efforts. It would be a felicitous ideal adjustment, if the moments of strain in one of the parallel courses were to coincide with the moments of ease in the rest.

Hardly any kind of study or exercise is so complicated and many-sided as to press alike upon all the energies of the system; hence there is an obvious propriety in making such variations as would leave unused as few of our faculties as possible. This principle necessarily applies to every mental process—acquirement, production, and enjoyment. The working out of the principle supposes that we are not led away by the mere semblance of variety.

Let us endeavor to assign the differences of subject that afford relief by transition.

There are many kinds of change that are merely another name for simple remission of the intellectual strain. When a severe and difficult exercise is exchanged for an easy one, the agreeable effect is due not to what we engage in, but to what we are relieved from. For letting down the strain of the faculties, it is sometimes better to take up a light occupation for a time than to be totally idle.

The exchange of study for sport has the twofold advantage of muscular exercise and agreeable play. To pass from anything that

is simply laborious to the indulgence of a taste or liking, is the fruition of life. To emerge from constraint to liberty, from the dark to the light, from monotony to variety, from giving to receiving, is the exchanging of pain for pleasure. This, which is the substantial reward of labor, is also the condition of renovating the powers for further labor and endurance.

To come closer to the difficulty in hand. The kind of change that may take place within the field of study itself, and that may operate both as a relief from strain and as the reclamation of waste ground, is best exemplified in such matters as these: In the act of learning generally there is a twofold attitude—observing what is to be done, and doing it. In verbal exercises, we first listen and then repeat; in handicraft, we look at the model, and then reproduce it. Now, the proportioning of the two attitudes is a matter of economical adjustment. If we are kept too long on the observing stretch, we lose the energy for acting; not to mention that more has been given us than we are able to realize. On the other hand, we should observe long enough to be quite saturated with the impression; we should have enough given us to be worthy of our reproducing energy. Any one working from a model at command learns the suitable proportion between observing and doing. The living teacher may err on either side. He may give too much at one dose; this is the common error. He may also dole out insignificantly small portions, which do not evoke the sense of power in the pupils.

When an arduous combination is once struck out, the worst is over, but the acquisition is not completed. There is the further stage of repetition and practice, to give facility, and insure permanence. This is comparatively easy. It is the occupation of the soldier after his first year. There is a plastic process still going on, but it is not the same draft upon the forces as the original struggles. At this stage, other acquirements are possible, and should be made. Now, in the course of training, it is a relief to pass from the exercises that are entirely new and strange, to those that have been practised and need only to be continued and confirmed.

Before considering the alternations of departments of acquisition, we may advert to the two different intellectual energies called, respectively, Memory and Judgment. These are in every way distinct, and in passing from the one to the other there is a real, and not merely an apparent, transition. Memory is nearly identical with the retentive, adhesive, or plastic faculty, which I have assumed to be perhaps the most costly employment of the powers of the mind and brain. Judgment, again, may be simply an exercise of discrimination; it may also involve similarity and identification; it may further contain a constructive operation. It is the aspect of our intellectual power that turns to account our existing impressions, as contrasted with the power that adds to our accumulated stores. The most de-

lightful and fructifying of all the intellectual energies is the power of similarity and agreement, by which we rise from the individual to the general, trace sameness in diversity, and master, instead of being mastered by, the multiplicity of Nature.

Much more would be necessary to exhaust the nature of the opposition between exercises of memory and exercises of judgment. Language and science approximately represent the contrast, although language does not exclude judgment, and science demands memory. But, in the one region, mere adhesion is in the ascendant, and, in the other, the detection of similarity in diversity is the leading circumstance. There is thus a real transition, and change of strain, in passing from the one class of studies to the other; the only qualifying circumstance is that in early years, routine adhesion plays the greatest part—being, in fact, easier than the other line of exertion, for reasons that can be divined.

We can now see what are the departments that constitute the most effective transitions or diversions, whereby relief may be gained at one point, and acquirement pushed at some other. In the muscular acquirements, we have several distinct regions—the body generally, the hand in particular, the voice (articulate), and the voice (musical). To pass from one of these to the other is almost a total change. Then, as to the sense engaged, we may alternate between the eye and the ear, making another complete transition. Further, each of the sense-organs has distinguishable susceptibilities, as color and form to the eye, articulation and music to the ear.

Another effective transition is from books or spoken teaching to concrete objects as set forth in the sciences of observation and experiment. The change is nearly the same as from an abstract subject like mathematics to one of the concrete and experimental sciences, as botany and chemistry. A still further change is from the world of matter to the world of mind, but this is liable to assume false and delusive appearances.

It has been well remarked that arithmetic is an effective transition from reading and writing. The whole strain and attitude of the mind are entirely different, when the pupil sets to perform sums after a reading-lesson. The mathematical sciences are naturally deemed the driest and hardest of occupations to the average mind; yet there may be occupations such as to make them an acceptable diversion. I have known clergymen whose relaxation from clerical duty consisted in algebraical and geometrical problems.

The fine-art acquisitions introduce an agreeable variety, partly by bringing distinctive organs into play, and partly by evoking a pleasurable interest that enters little, if at all, into other studies. The more genial part of moral training has a relationship to art. The severer exercises are a painful necessity, and not an agreeable transition from anything.

The introduction of narratives, stirring incidents, and topics of human interest generally, is chiefly a mode of pleasurable recreation. If taken in any other view, it falls under some of the leading studies, and engages the memory, the judgment, or the constructive power, and must be estimated accordingly.

Bodily training, fine art (itself an aggregate of alternations), language, science, do not exhaust all the varieties of acquirement, but they indicate the chief departments whose alternation gives relief to the mental strain, and economizes power in the whole. Under these, as already hinted, there are variations of attitude and exercise; from listening to repeating, from learning a rule, to the application of it in new cases, from knowledge generally to practice.

The transition from one language to another, being a variation in the nature of the impressions, is a relief of an inferior kind, yet real. It is the more so, if we are not engaged in parallel exercises; learning strings of Latin words in the morning, and of German in the evening, does not constitute any relief.

From one science to another, the transition may be great, as already shown, or it may be small. From botany to zoölogy affords a transition of material, with similarity in form. Pure and mixed mathematics are the very same thing. The change from algebra to geometry is but slightly refreshing; from geometry to trigonometry, and geometrical conic sections, is no relief to any faculty.

There are minor incidents of relief and alternation that are not to be despised. Passing from one master to another (both being supposed competent) is a very sensible and grateful change; even the change of room, of seat, of posture, is an antidote against weariness, and helps us in making a fresh start. The jaded student relishes a change of books even in the same subject, the alteration from solitude to company.

Some subjects are in themselves so mixed that they would appear to contain the elements of a sufficiently various occupation of the mind; such are geography, history, and what is called literature, when studied both for expression and for subject-matter. This variety, however, is not altogether a desirable thing. The analytic branch of the science of education would have to resolve those aggregates into their constituent parts, and consider not only their respective contributions to our mental culture, but also the advantages and disadvantages attending the mixture.

Culture of the Emotions.—The laws attainable in the departments of emotion and volition are the immediate prelude to moral education, in which all the highest difficulties culminate. There are emotional and volitional forces prior to any cultivation, and there are new forces that arise through cultivation; yet from the vagueness attaching to the measured intensity of feelings and emotions, it is not easy to value the separate results.

The general laws of retentiveness equally apply to emotional growths. There must be repetition and concentration of mind to bring about a mental association of pleasure or of pain with any object. But there are peculiarities in the case such as to demand for it a supplementary treatment. Perhaps the best way of bringing out the points is to indicate the modes or species of growths, coming under emotion and volition, that most obtrude themselves upon the notice of the educationist.

I. We may quote first the associations of pleasure and pain with the various things that have been present to us, during our experiences of delight and suffering. It is well known that we contract pleasurable regards toward things originally indifferent that have been often present to us in happy moments. Local associations are among the most familiar examples; if our life is joyous, we go on increasing our attachments to our permanent home and neighborhood; we are severely tried when we have to migrate; and one of our holiday delights is to revisit the scenes of former pleasures. A second class of acquired feelings includes the associations with such objects as have been the instruments of our avocations, tastes, and pursuits. The furnishings of our home, our tools, weapons, curiosities, collections, books, pictures—all contract a glow of associated feeling, that helps to palliate the dullness of life. The essence of affection, as distinguished from emotion, is understood to be the confirming and strengthening of some primary object of our regards. As our knowledge extends, we contract numerous associations with things purely ideal, as with historic places, persons, and incidents. I need only allude to the large field of ceremonies, rites, and formalities, which are cherished as enlarging the surface of emotional growths. The fine-art problem of distinguishing between original and derived effects consists in more precisely estimating these acquired pleasures.

The educationist could not but cast a longing eye over the wide region here opened up, as a grand opportunity for his art. It is the realm of vague possibility, peculiarly suited to sanguine estimates. An education in happiness pure and simple, by well-placed joyous associations, is a dazzling prospect. One of Sydney Smith's pithy sayings was, "If you make children happy now, you make them happy twenty years hence, by the memory of it." This referred, no doubt, to the home-life. It may, however, be carried out also in the school-life; and enthusiasm has gone the length of supposing that the school may be so well constituted as to efface the stamp of an unhappy home.

The growth of such happy associations is not the work of days; it demands years. I have endeavored to set forth the psychology of the case ("The Emotions and the Will," third edition, p. 89), and do not here repeat the principles and conditions that seem to be involved. But the thread of the present exposition would be snapped, if I were not to ask attention to the difference in the rate of growth when the

feelings are painful; the progress here is not so tedious nor so liable to thwarting and interruption.

With understood exceptions, pleasure is related physically with vitality, health, vigor, harmonious adjustment of all the parts of the system; it needs sufficiency of nutriment or support, excitement within due limits, the absence of everything that could mar or irritate any organ. Pain comes of the deficiency in any of these conditions, and is therefore as easy to bring about and maintain as the other is difficult. To evoke an echo or recollection of pleasure, is to secure, or at least to simulate, the copiousness, the due adjustment and harmony of the powers. This may be easy enough when such is the actual state at the time, but that is no test. What we need is to induce a pleasurable tone, when the actuality is no more than indifferent or neutral, and even, in the midst of actual pain, to restore pleasure by force of mental adhesiveness. A growth of this description is, on *a priori* grounds, not likely to be very soon reached.

On the other hand, pain is easy in the actual, and easy in the ideal. It is easy to burn one's fingers, and easy to associate pain with a flame, a cinder, a hot iron. Going as spectators to visit a fine mansion, we feel in some degree elated by the associations of enjoyment; but we are apt to be in a still greater degree depressed by entering the abodes of wretchedness, or visiting the gloomy chambers of a prison.

II. The facility of painful growths is not fully comprehended, until we advert to the case of passionate outbursts or the modes of feeling whose characteristic is explosiveness. These costly discharges of vital energy are easy to induce at first hand, and easy to attach to indifferent things, so as to be induced at second hand likewise. Very rarely are they desirable in themselves; our study is to check and control them in their original operation, and to hinder the rise of new occasions for their display. One of the best examples is terror, an explosive and wasteful manifestation of energy under certain forms of pain. If it is frequently stimulated by its proper causes, it attaches itself to by-standing circumstances with fatal readiness, and proceeds with no tardy steps. Next is irascibility, also an explosive emotion. It too, if ready to burst out by its primary causes, soon enlarges its borders by new associations. It is in every way more dangerous than terror. The state of fear is so miserable that we would restrain it if we could; the state of anger, although containing painful elements, is in its nature a luxurious mood; and we may not wish either to check it in the first instance, or to prevent it from spreading over collateral things. When any one has stirred our irascibility to its depths, the feeling overflows upon all that relates to him. If this be pleasure, it is a pleasure of rapid growth; even in tender years we may be advanced in hatreds. That combination of terror and irascibility giving rise to what is named antipathy is (unless strongly resisted) a state easy to assume and easy to cultivate, and is in wide

contrast with the slow growth of the pleasures typified under the foregoing head. A signal illustration of explosiveness is furnished by laughter, which has both its original causes, and also its factitious or borrowed stimulants. This is an instance where the severity of the agitation provokes self-control, and where advancing years contract rather than enlarge the sphere. As the expression of disparaging and scornful emotions, its cultivation has the facility of the generic passion of malevolence. We may refer, next, to the explosive emotion of grief, which is in itself seductive, and, if uncontrolled, adds to its primary urgency the force of a habit all too readily acquired. There is, moreover, in connection with the tender emotion, an explosive mode of genuine affection, of which the only defect is its being too strong to last: it prompts to a degree of momentary ardor that is compatible with a relapse into coldness and neglect. This, too, will spontaneously extend itself, and will exemplify the growth of emotional association with undesirable rapidity.

What has now been said is but a summary and representation of familiar emotional facts. Familiar also is the remark that explosiveness is the weakness of early life, and is surmounted to a great degree by the lapse of time and the strengthening of the energies. The encounter with others in every-day life begets restraint and control; and one's own prudential reflections stimulate a further repression of the original outbursts, by which also their growth into habits is retarded. In so far as they are repressed by influence from without, and counter-habits established, as a part of moral education, I have elsewhere stated what I consider the two main conditions of such a result—a powerful initiative, and an unbroken series of conquests. When these conditions are exemplified through all the emotions in detail, the specialties of the different genera—fear, anger, love, and the rest—are sufficiently obvious.

III. The chief interest always centres in those associations that, from their bearing on right and wrong conduct, receive the name "Moral." The class just described have this bearing in a very direct form; while the first class indirectly subserves moral ends. But when we approach the subject with an express view to moral culture, we must cross the field of emotional association in general by a new track.

The newly-appointed professors of the theory of education are perhaps not yet fully aware that, when they venture upon the troubled arena of moral education, they will not be able to evade the long-standing question, What is the moral faculty? A very short argument will prove the point. Moral improvement is obviously a strengthening of this so-called moral faculty, or conscience—increasing its might (in Butler's phrase) to the level of its right. But in order to strengthen an energy we must know what it is: if it is a simple, we must define it in its simplicity; if it is a compound, we must

assign its elements, with a view to define them. The unconventional handling of moral culture by Bentham and James Mill is strongly illustrative of this part of the case. Mill's view of the moral sense is the theory of thorough-going derivation; and, in delineating the process of moral education, he naturally follows out that view. He takes the cardinal virtues piecemeal; for example: "Temperance bears a reference to pain and pleasure. The object is, to connect with each pain and pleasure those trains of ideas which, according to the order established among events, tend most effectually to increase the sum of pleasures upon the whole, and diminish that of pains." The advocates of a moral faculty would have a different way of inculcating temperance—which, however, I will not undertake to reproduce.

It will not be denied, as a matter of fact, that the perennial mode of insuring the moral conduct of mankind has been punishment and reward—pain and pleasure. This method has been found, generally speaking, to answer the purpose; it has reached the springs of action of human beings of every hue. No special endowment has been needed to make man dread the pains of the civil authority. Constituted as we are to flee all sorts of pain, we are necessarily urged to avoid pain when it comes as punishment. Education is not essential to this effect any more than it is essential to our avoiding the pains of hunger, cold, or fatigue.

Those who demur to the existence of a special faculty, different from all the other recognized constituents of mind—feeling, will, or intellect—are not to be held as declaring that conscience is entirely a matter of education; for, without any education at all, man may be, to all intents and purposes, moral. What is meant by the derivative theory of conscience is, that everything that it includes is traceable to some one or other of the leading factors of our nature: first of all to will or volition, motived by pain and pleasure, and next to the social and sympathetic impulses. The coöperation of these factors supplies a nearly all-powerful impetus to right conduct, wherever there is the external machinery of law and authority. Education, as a third factor, plays a part, no doubt, but we may overrate as well as underrate its influence. I should not be far out in saying that seventy-five per cent. of the average moral faculty is the rough and ready response of the will to the constituted penalties and rewards of society.

At the risk of embroiling the theory of education in a controversy that would seem to be alien to it, I conceive it to be necessary to make these broad statements, as a prelude to inquiring what are the emotional and volitional associations that constitute the made-up or acquired portion of our moral nature. That education is a considerable factor is shown by the difference between the children that are neglected and such as are carefully tended; a difference, however, that means a good deal more than education.

When the terrors of the law are once thoroughly understood, it

does not seem as if any education could add to the mind's own original repugnance to incur them; and, on the other hand, when something in the nature of reward is held forth to encourage certain kinds of conduct, we do not need special instruction to prompt us to secure it. There is, indeed, one obvious weakness that often nullifies the operation of these motives, namely, the giving way to some present and pressing solicitation, a weakness that education might do something for, but rarely does. The instructor that could reform a victim to this frailty would effect something much wider than moral improvement properly includes.

Going in search of some distinct lines of emotional association that enhance the original impulses coincident with moral duty, I think I may cite the growth of an immediate, independent, and disinterested repugnance to what is uniformly denounced and punished as being wrong. This is a state or disposition of mind forming part of a well-developed conscience; it may grow up spontaneously under the experience of social authority, and it may be aided by inculcation; it may, however, also fail to show itself. This is the parallel of the much-quoted love of money for itself; but is not so facile in its growth. For one thing, the mind must not treat authority as an enemy to be counted with, and to be obeyed only when we can't do better. There must be a cordial acquiescence in the social system as working by penalties; and this needs the concurrence of good impulses together with reflection on the evils that mankind are saved from. It is by being favorably situated in the world, as well as by being sympathetically disposed, that we contract this repugnance to immoral acts in themselves, and without reference to the penalties that are behind; and thus perform our duties when out of sight, and not in the narrowness of the letter, but in the fullness of the spirit. It would take a good deal of consideration to show how the schoolmaster might coöperate in furthering this special growth.

THE NORWEGIAN LEMMING AND ITS MIGRATIONS.

By W. DUPPA CROTCH, M. A., F. L. S.

AMONG the many marvelous stories which are told of the Norwegian lemming (*Myodes lemmus*, Linn.), there is one which seems so directly to point to a lost page in the history of the world, that it is worth a consideration which it appears hitherto to have escaped. I allude to the remarkable fact that every member of the vast swarms which periodically almost devastate Norway perishes voluntarily, or at least instinctively, in the ocean. But as among my readers some may not be familiar with the lemming, a brief descrip-

tion of the animal itself will not be out of place. It is a vole, like our short-tailed field-mouse, very variable in size and color, but the figures (Fig. 1), which are about half the natural size, will be found to resemble the majority in the latter respect. The claws, especially on the fore-foot, are strong and curved; the tail is very short, the ears scarcely visible, and the bead-like, black eyes seem always to notice objects above them rather than those in any other direction. During the summer these animals form their nests under stones, usually betraying their habitations by the very care which they take to keep them

Fig. 1.—Group of Lemmings.

sweet and clean. In winter, however, they form long galleries through the turf and under the snow in search of their food, which is exclusively vegetable; and it is at this time that those ravages are caused which have led the Norwegians in former times to institute a special form of prayer against their invasions. There are several species of lemming, easily recognizable, and with well-marked geographical range; but it is to the Scandinavian species only that the following old description applies: "It lives on the shoots of the dwarf-birch, reindeer lichens, and other mosses; it hisses and bites; in winter it runs under the snow; and about every tenth year, especially before an extremely severe winter, the whole army of animals, in the autumn and at night, migrates in a direct line." According to Olaus Magnus they fall from the clouds; and Pennant narrates that "they descend from the Kjölen, marching in parallel lines three feet apart; they trav-

erse Nordland and Finmark, cross lakes and rivers, and gnaw through hay and corn stacks rather than go round. They infect the ground, and the cattle perish which taste of the grass they have touched; nothing stops them—neither fire, torrents, lakes, nor morasses. The greatest rock gives them but a slight check; they go round it, and then resume their march directly without the least division. If they meet a peasant they persist in their course, and jump as high as his knees in defense of their progress. They are so fierce as to lay hold of a stick and suffer themselves to be swung about before they quit their hold. If struck they turn about and bite, and will make a noise like a dog. Foxes, lynxes, and ermines, follow them in great numbers, and at length they perish, either through want of food or by destroying one another, or in some great water, or in the sea. They are the dread of the country, and in former times spiritual weapons were exerted against them; the priest exorcised them, and had a long form of prayer to arrest the evil. Happily it does not occur frequently —once or twice only in twenty years. It seems like a vast colony of emigrants from a nation overstocked, a discharge of animals from the northern hive which once poured forth its myriads of human beings upon Southern Europe. They do not form any magazine for winter provision, by which improvidence, it seems, they are compelled to make their summer migration in certain years, urged by hunger. They are not poisonous, as vulgarly reported, for they are often eaten by the Laplanders, who compare their flesh to that of squirrels."

M. Guyon disposes of the theory that these migrations are influenced by *approaching* severe weather, since the one witnessed by himself took place in the spring; also the superabundance of food during the previous autumn precluded all idea of starvation. He therefore adopts a third view, that excessive multiplication in certain years necessitates emigration, and that this follows a descending course, like the mountain-streams, till at length the ocean is reached. Mr. R. Collett, a Norwegian naturalist, writes that in November, 1868, a ship sailed for fifteen hours through a swarm of lemmings, which extended as far over the Trondhjems-fjord as the eye could reach.

I will now relate my own experience of the lemming during three migrations in Norway, and in a state of captivity in England. The situation of Heimdalen, where I reside during the summer months, is peculiarly well suited for observation of their migrations, lying as it does at an elevation of 3,000 feet, and immediately under the highest mountains in Scandinavia; and yet, excepting during migration, I have never seen or been able to procure a specimen. It was in the autumn of 1867 that I first heard the peculiar cry of the lemming, guided by which I soon found the pretty animal backed up by a stone, against which it incessantly jerked its body in passionate leaps of rage, all the while uttering a shrill note of defiance. The black, bead-

like eyes seemed starting from their sockets, and the teeth shone white in the sunlight. I hastily snatched at the savage little creature, but it sprang completely round, fastened its teeth sharply in my hand, and taking advantage of my surprise escaped under a large stone, whence I could not dislodge it. A Norwegian friend who accompanied me by no means shared my feelings of satisfaction at the sight of a lemming. "We shall have a severe winter and no grass next spring, owing to those children of Satan!" was his comment on the event. However, it was many a month before I saw another; then, on lifting a flat stone, I found six in a nest of dried grass, blind, and apparently but just born. In a few days the whole fjeld became swarming with these pretty voles; at the same time white and blue foxes made their appearance, and snowy owls and many species of hawks became abundant. My dogs, too, were annoyed by the rash courage of the new-comers, which would jump at their noses even when slowly drawing on game, so that they never spared a lemming, though they never ate them till last year, when I observed that they would eat their heads only, rejecting the body, although they devoured the common field-mouse to the end of his tail. As the season advanced and snow covered the ground, the footprints and headless carcasses told plainly how hard it must be for a lemming to preserve its life, although there can be no doubt that its inherent pugnacity is its worst enemy. In this country we fail to conceive how much active life goes on beneath the snow, which in more northern latitudes forms a warm roof to numerous birds, quadrupeds, and insects, which are thus enabled to secure an otherwise impossible sustenance. At the same time, as I have already noticed, a fearful struggle for existence is carried on during the long autumnal nights, before the snow has become a protection rather than a new source of danger to all save predaceous animals. It was a curious sight, when the whole visible landscape was an unbroken whiteness, to see a dark form suddenly spring from the surface and scurry over the snow, and again vanish. I found that some of the holes by means of which this feat was executed were at least five feet in depth, yet even here was no safety, for the reindeer often kill the lemmings by stamping on them, though I do not believe their bodies are ever eaten.

During the autumn I noticed no migration, or rather there was only an immigration from some point to the eastward, and in the subsequent migrations of 1870–'71, and 1875–'76, I still found the same state of things. The animals arrived during early autumn, and immediately began to breed; there was no procession, no serried bands undeterred by obstacles, but there was an invasion of temporary settlers, which were speedily shut out from human view by the snow, and it was not till the following summer that the army, reënforced by five or six generations, went out to perish like the hosts of Pharaoh. On calm mornings my lake, which is a mile

in width, was often thickly studded with swimming lemmings, every head pointing westward; but I observed that when my boat came near enough to frighten them they would lose all idea of direction, and frequently swim back to the bank they had left. When the least wind ruffled the water every swimmer was drowned; and never did frailer barks tempt a more treacherous sea, as the wind swept daily down the valley, and wrecked all who were then afloat. It is impossible not to feel pity for these self-haunted fugitives. A mere cloud passing over the sun affrighted them; the approach of horse, cow, dog, or man, alike roused their impotent anger, and their little bodies were convulsively pressed against the never-failing stone of vantage (*see* Fig. 1), while they uttered cries of rage. I collected 500 skins, with the idea of making a rug, but was surprised to find that a portion of the rump was nearly always denuded of hair, and it was long before I discovered that this was caused by the habit of nervously backing up against a stone, of which I have just spoken. As this action is excited by every appearance of an enemy, it seems surprising that a natural callosity should not take the place of so constant a lesion; possibly, however, the time during which this lesion occurs is too short to cause constitutional change.

Early in the autumn, and just a year after their arrival at Heimdalen, the western migration commenced anew. Every morning I found swarms of lemmings swimming the lake diagonally, instead of diverging from their course so as to go round it, and mounting the steep slopes of Heimdals-hö (Figs. 2 and 3) on their way to the coast,

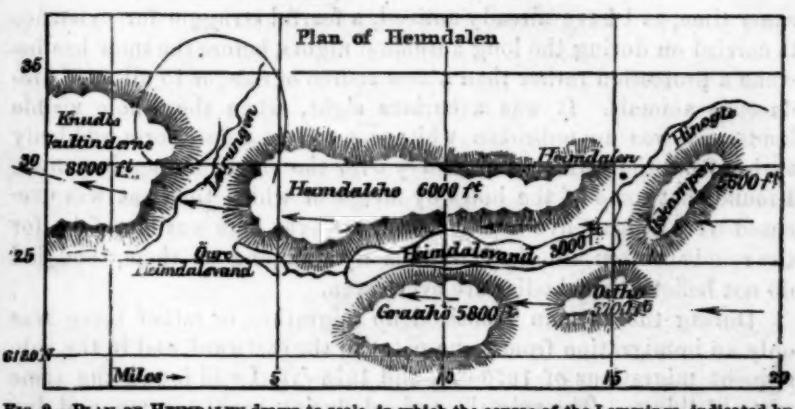
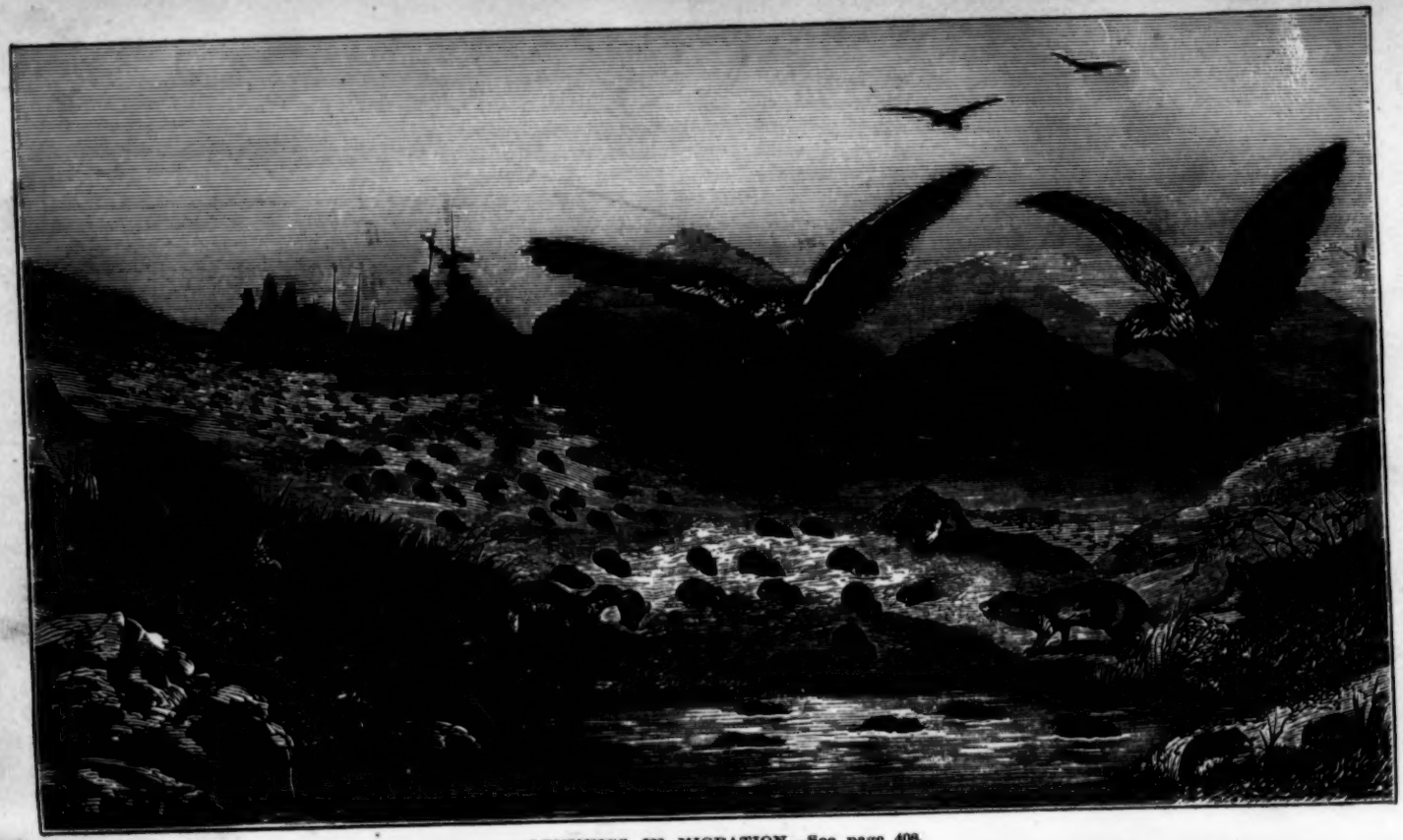


FIG. 2.—PLAN OF HEIMDALEN drawn to scale, in which the course of the Lemmings, indicated by the arrows, is seen to cross Lake Heimdalsvand and the swift river Leirungen, both of which might be avoided by a slight *détour*. The river is of glacier origin, very cold and very rapid.

where the harassed crowd, thinned by the unceasing attacks of the wolf, the fox, and the dog, and even the reindeer, pursued by eagle, hawk, and owl (*see* frontispiece), and never spared by man himself, yet still a vast multitude, plunges into the Atlantic Ocean on the first



LEMMINGS IN MIGRATION.—See page 408.

calm day, and perishes with its front still pointing westward. No faint heart lingers on the way; and no survivor returns to the mountains.

There appears to have been a difficulty in keeping these restless creatures in captivity, both because they escape through incredibly small apertures (generally, however, dying from internal injuries thus caused), and because they will gnaw through a stout wooden cage in one night, and devote every spare moment to this one purpose, with a pertinacity worthy of Baron Trenck. At all events, few have been brought alive to this country, and none have survived. At present (February, 1877) I have one which I have preserved since September last, defeating his attempts at escape by lining the cage with tin, and allowing him a plentiful supply of fresh water, in which he is always dabbling. With the approach of winter all his attempts to escape ceased, and I now always take the little stranger for an airing in my closed hands while his bed is being made and his room cleaned out. He seems to like this, but after a few minutes a gentle nibble at my finger testifies to his impatience; and if this be not attended to, the

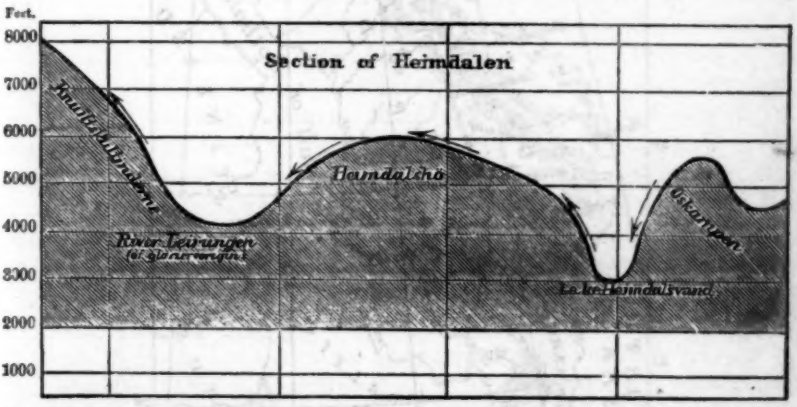


FIG. 3.—SECTION OF HEIMDALEN showing the Lemmings' track, which does not follow the watershed.

biting progresses in a *crescendo* scale until it becomes unbearable, although it has never under these circumstances drawn blood. My little prisoner shows few other signs of tameness, but the fits of jumping, biting, and snarling rage have almost ceased. I expect, however, that, with the return of spring, the migratory impulse will be renewed, and that he will kill himself against the wires of his cage like a swallow.

The reader is now in a position to consider the three questions raised by the above facts, and those questions are as follow: 1. Whence do the lemmings come? 2. Whither do they go? 3. Why do they migrate at all? With regard to the first, no one has yet supplied an answer. They certainly do not exist in my neighborhood

during the intervals of migrations; and the Kjölen range was probably selected as their habitat, not because it was proved to be so, but because so little is known about it at all. The answer to the second question is certain: They go to the sea. Those on the east of the backbone of Norway go to the Gulf of Bothnia, and those on the west to the Atlantic Ocean (Fig. 4), and out of eighteen migrations which have been investigated, one only, and that very doubtful, is reported

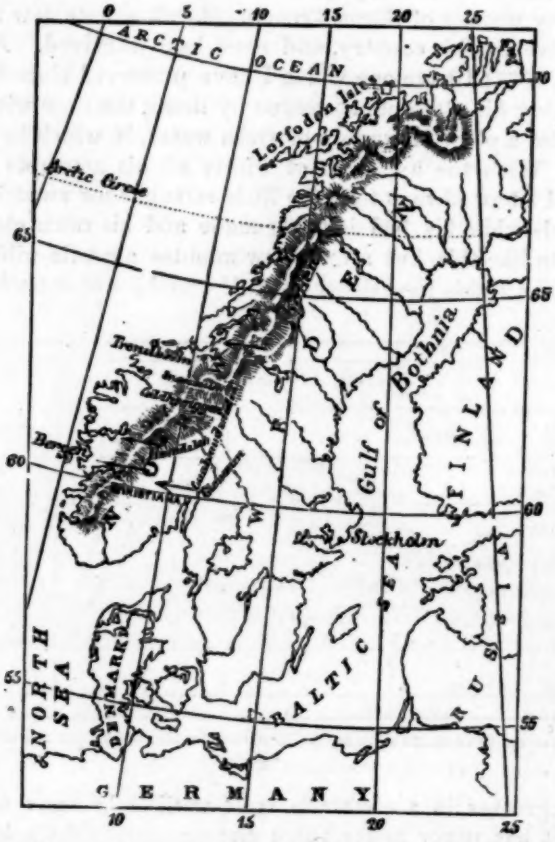


FIG. 4.—OUTLINE MAP OF SCANDINAVIA. The two main valleys, Gudbrandsdalen and the valley of the Glommen, run nearly north and south. The course of the Lemmings crosses these at right angles, as indicated by the arrows.

to have been directed southward. The question as to the cause of these migrations remains, and is a very difficult one to answer. We have been told that the foreknowledge of approaching severe weather predetermines the exodus: my experience, however, contradicts this, and it may be dismissed as merely a popular superstition. Unusual reproduction and consequent deficiency of food is a more plausible theory; but I have always noticed that, just as with the swallow, a

few individuals have preceded the main body, and that during the first autumn the numbers are never large, but, after a winter spent beneath the snow, they begin to breed with the first days of summer, and thus develop the extraordinary multitude which is, as it well may be, the astonishment and terror of the country. It appears, then, that excessive reproduction is rather the result than the cause of migration. It has also been suggested that the course taken by the lemmings follows the natural declivities of the country, but a reference to the maps will show that in that case nearly all the Norwegian migrations should take a southerly route, which is by no means the case. On the contrary, westward at Heimdalen means across a rapid river, over a wide lake, and up a steep, rocky, and snowy mountain, and this is the course which is followed. Now, this ends eventually in the ocean, and thus we are again landed at the question from which we set out. After all, it is not the power of direction which is so remarkable; this is a faculty possessed by many animals, and by man himself in a savage state. A young dog which I took from England, and then from my home in Vaage by a path to Heimdalen, a distance of forty-six miles, ran back the next morning by a direct route of his own, crossing three rapid rivers and much snow, and accomplishing the distance in six hours, without the vestige of a path. This same dog afterward repeated the feat, but followed the path, and took two days in reaching his destination, hindered and not aided, as I believe, by his experience. Herr Palmén, indeed, says, "Experience guides migration, and the older migrants guide the younger," like one of Mr. Cook's personally-conducted tours. This obviously cannot be the case with the lemmings.

It is now generally admitted that instinct is merely inherited experience, and is, therefore, primarily calculated to benefit the species, unless, indeed, circumstances have changed meanwhile more rapidly than the structures to which the phenomena of instinct are due. Now, the lemmings during their wanderings pass through a land of milk and honey, where, if their instincts could be appeased, they might well take up a permanent abode; and yet they pass on, while their congener, the field-vole, remains in quiet possession of the quarters from which he was temporarily ousted. It is, indeed, almost as strange a sight to see the holes, the deeply-grooved runs, and the heaps of refuse, of these restless creatures, which have passed away but yesterday, as it is to see the fjelds suddenly become alive with a new and boisterous tenant, who, like another Ishmael, has the hand of all men against him.

Now, if we compare the migration of the lemmings with that of our more familiar swallows, we find that the latter obviously seek a more genial climate and more abundant food, returning to us as surely as summer itself; nor do they ever, so far as I know, breed on their passage. The swifts, which stay but a short time with us, remain in

Norway barely long enough to rear their young before returning to Africa. It is difficult, in fact, to find a parallel case to that of the lemmings. The nearest approach, perhaps, is afforded by the strange immigration of Pallas's sand-grouse in 1863, when a species whose home is on the Tartar steppes journeyed on in considerable numbers to the most western shores of Europe, and very probably many perished, like the lemmings, in the waves of the Atlantic. But to revert to the swallows, which annually desert Europe to visit Africa. Let us suppose that these birds were partial migrants only—that is, that a remnant remained with us after the departure of the main body—and further suppose that the continent of Africa were to become submerged, would not many generations of swallows still follow their inherited migratory instincts, and seek the land of their ancestors through the new waste of waters, while the remaining stock, unimpeded by competition, would sooner or later, according to the seasons, recruit the ranks for a new exodus? It appears quite as probable that the impetus of migration toward this lost continent should be retained as that a dog should turn round before lying down on a rug, merely because his ancestors found it necessary thus to hollow out a couch in the long grass.

Well, then, is it probable that land could have existed where now the broad Atlantic rolls? All tradition says so; old Egyptian records speak of Atlantis, as Strabo and others have told us. The Sahara itself is the sand of an ancient sea, and the shells which are found upon its surface prove that no longer ago than the Miocene period a sea rolled over what now is desert. The voyage of the Challenger has proved the existence of three long ridges in the Atlantic Ocean, one extending for more than 3,000 miles; and lateral spurs may, by connecting these ridges, account for the marvelous similarity in the fauna of all the Atlantic islands. However, I do not suppose that the lemmings ever went so far south, though they are found as fossils in England; but it is a remarkable fact that, while the soundings off Norway are comparatively shallow for many miles, we find a narrow but deep channel near Iceland, which probably has prevented the lemming from becoming indigenous there, although an American species was found in Greenland during the late arctic expedition. If, as is probable, the Gulf Stream formerly followed this deep channel, its beneficent influence would only extend a few miles from the coast, which would also have reached to a great distance beyond the present shores of Norway, and thus the lemmings would have acquired the habit of traveling westward in search of better climate and more abundant food; and, as little by little the ocean encroached on the land, the same advantages would still be attained. And thus, too, we find an explanation of the fate which befalls the adventurous wanderers; for we have already seen that no lake deters them, and that they frequently cross the fjords, or arms of the sea, in safety. No

doubt, therefore, they commit themselves to the Atlantic in the belief that it is as passable as those lakes and fjords which they have already successfully dared, and that beyond its waves lies a land which they are never destined to reach.

The submerged continent of Lemuria, in what is now the Indian Ocean, is considered to afford an explanation of many difficulties in the distribution of organic life, and I think the existence of a Miocene Atlantis will be found to have a strong elucidative bearing on subjects of greater interest than the migration of the lemming. At all events, if it can be shown that land existed in former ages where the North Atlantic now rolls, not only is a motive found for these apparently suicidal migrations, but also a strong collateral proof that what we call instincts are but the blind and sometimes even prejudicial inheritance of previously-acquired experience.—*Popular Science Review.*

MATCHES.

By JOHN A. GARVER, A.B.

AN article in THE POPULAR SCIENCE MONTHLY of last November gave an interesting account of the early history of fire, showing how that important element was obtained in primitive times. We will now consider the development of the modern art of extemporizing fire. In a match-making age those crude and ancient processes are regarded with curiosity, but that they ever possessed any practical value is scarcely realized; while the use of our prompt and cheap devices for producing combustion has grown to be such a matter of course that a thought is hardly given to the time when they did not exist. During the whole of the last century, however, and in the early part of the present century, the invention of a safe and trustworthy agent for furnishing fire was regarded as one of the great wants of the age; and fifty years ago a tinder-box was as much an indispensable article of household economy as is the well-filled match-safe to-day. The sulphur-match now in use is not so old as our railroads, and but a few years ago there occurred frequent examples of burns caused by the explosion of the match and the projection of its burning pieces.

Among the more civilized nations, the tinder-box, with the flint and steel, became known in the fourteenth century, and continued to be used, notwithstanding the other methods, down to the invention of the lucifer-match. The tinder was formed by the partial combustion of a linen or cotton rag, and, being ignited by striking a spark upon it from the flint and steel, communicated its fire in turn to the match.

When phosphorus was first discovered, two hundred years ago, it

was utilized in London by rubbing it between two pieces of brown paper. A fire was produced in this way, which lighted a splint tipped with sulphur. Another early method was to put a piece of phosphorus in a vial and stir it with a hot iron wire, after which the vial was corked tightly for use. As the phosphorus was partially burned in the confined portion of the air, the interior of the vial became covered with oxide of phosphorus. When a light was desired, a sulphur-tipped splint was dipped into the bottle, a portion of the phosphorus adhered to it, and, being brought into the air, the chemical action between the two substances caused a flame which lighted the splint.

When chlorate of potash is mixed with loaf-sugar, a drop of sulphuric acid let fall on the compound will produce a brilliant flame. This principle involved the next stage in the development of the match. The end of the splint was tipped with the mixture, colored with vermilion, and ignited in a little bottle containing asbestus and sulphuric acid. The various ingredients were then put into a handsome metal case, and the patent was ready to take its place among the wealthy; for, at first, a single case of a hundred sold for four dollars and seventy-five cents. There were certain drawbacks to the practical use of this invention, as the acid would become weak by absorbing moisture from the air, and the match, instead of producing the brilliant flame expected, merely smouldered and spurted the acid about, to the detriment of good clothes and a peaceful disposition. As a stroke of economy, such a wetted match was occasionally put back among the rest for future use; but, coming in contact with one more energetic, it ignited the latter, and thus the whole collection was lighted at once and shot out in all directions. From this dip-splint, oxymuriate match, or instantaneous light-box, as it was variously termed, lucifers trace their lineal descent.

John Walker, an Englishman, is generally supposed to have invented lucifer-matches in 1829. The first real friction-match was made in England in 1832, and was a compound of chlorate of potash and sulphuret of antimony. It was ignited by strong compression between two pieces of sand-paper, and, as a natural consequence, the heads frequently flew off in all directions. A year or two later, phosphorus was substituted for the antimony; the matches were called "congreves," and the composition continued to be improved by using other constituents for part of the chlorate of potash.

The ease with which phosphorus is ignited by friction has caused it to be employed universally in the manufacture of matches. The particular proportions and the exact ingredients which make up the head of the match are jealously guarded by the manufacturers, each one claiming some advantage over the others. From one-twelfth to one-tenth is laid down as the best proportion of phosphorus to be employed. Glue, gum, or similar substances, are used for causing the composition to adhere to the splint. The use of glue is objectionable, as it

carbonizes and prevents combustion. In preparing the compound, the mucilaginous substance is dissolved in water till it assumes the consistency of thin sirup. After it is heated, the phosphorus is added in small pieces, and thoroughly incorporated by rubbing till cold. If it were left in this condition, however, the mass, upon becoming cold, would prevent the admission of air and hinder combustion. Some additional substance is necessary to supply the oxygen to it, such as red-lead, saltpetre, or chlorate of potash. Coloring-matter is also usually put into the solution: vermilion, if the tips are to be red; Prussian blue, if they are to be blue, etc. In making sulphur-matches, the ends of the splints are first dipped into melted sulphur, and afterward touched to the surface of the phosphorus-paste. In lighting such a match, the process is as follows: the coating of the head is broken by friction, the phosphorus is kindled, and the heat of its combustion decomposes the salts; these, in their decomposition, evolve oxygen, which provides the fuel, increases the heat, and causes the ignition of the sulphur, which in turn inflames the wood. The temperature required for kindling matches varies from 150° to 160° Fahr. The sulphur is what causes the peculiar brimstone-odor. Instead of sulphur, stearin, stearic acid, or paraffin, is used in the better kinds of matches. They burn more readily than the sulphur-matches, as the fatty matter and wood take fire together, while in the others the sulphur must first be consumed before the wood is ignited. The matches soaked in fatty matter also burn with a clearer and brighter light, and are free from the disagreeable odor due to the sulphur. A coating of varnish is sometimes employed to protect the head from moisture.

Before a box of matches can be sold, it has passed through about forty different processes, twenty for the matches and as many for the box. The wood used for the splints is commonly white-pine, free from knots. Other woods are also occasionally employed, as beech, birch, willow, poplar, and cedar. Much of the wood for this purpose is brought from Canada, and the match-manufacture is assuming such large proportions that it is making serious inroads into the supply of clear white-pine timber needed for other purposes. Formerly, the splints were cut by hand, and the composition was applied by the same means. Separate factories are now commonly employed for making the splints, and the entire labor is performed by machinery. As the manufacturers do not allow visitors in their buildings, it is impossible to describe exactly the machinery or the methods employed. By one process, the pine-wood is reduced to two-inch planks, which are cut into blocks the length of the ordinary match. These are put into a small machine, which at each stroke cuts off twelve splints, and at the following stroke delivers them upon an endless chain, which carries them to a sulphur-bath, where a wheel, revolving in the sulphur, coats their ends as they pass; farther on, a similar wheel applies the phosphorus. In this condition the matches are brought back across

the room, delivered in trays near the cutting-machine, and thence sent to the packing-room. In wax-matches, or vestas, the composition is attached to a few cotton-threads immersed in a mixture of paraffin and stearin. One or two hundred of these wicks are rolled around a cylinder and separated by a comb. They pass through a bath of melted wax and are afterward drawn through holes in a metal frame, which renders the tapers smooth, cylindrical, and of the proper size and shape. A mechanical knife cuts, at one time, all the wicks according to the determined length, from one to one and a quarter inch, after which the paste is applied to their ends with great rapidity.

In the manufacture of matches much trouble has been occasioned by the use of phosphorus, as its fumes attack the teeth of the workmen, and give rise to a disease known as caries of the jaw-bones. In some of the small and poorly-managed factories the men and children are never free from the fumes; their clothes and breath are luminous in the dark, and in the daytime white fumes may be seen escaping from them whenever they are seated by the fire. The phosphorus first attacks a decayed tooth, causing pain which constantly becomes greater. The gums are sore, the face swollen, and the teeth finally drop out. The suffering is excruciating, the patient finds little relief for months or years, and, in a severe case, there is loss of one or both jaw-bones, hindering mastication and ending in death. So alarming did this disease become in Germany at one time that it attracted the attention of the Government. No antidote has yet been discovered; but it can be prevented to a great extent by ventilation and cleanliness. We have inquired of several of the leading American manufacturers in regard to the subject, and all say that their workmen are not troubled in this manner. No examination of their teeth is enforced, the men being merely warned as to the consequences before they begin their work.

Partly as a remedy for this evil, the red or amorphous phosphorus was substituted for the ordinary variety. This possesses neither odor nor taste, is not poisonous, and can be handled with safety. The danger arising from the use of matches was magnified, because they could sometimes be seen in the dark, were liable to ignite on a warm shelf, and were poisonous to such an extent that children had been killed by using them as playthings. From red phosphorus resulted the safety-match. Many attempts were made to form a paste with red phosphorus and chlorate of potash without success, and finally the paste and phosphorus were separated. The heads now consist of a pasty mass composed mainly of sulphuret of antimony and chlorate of potash. The red phosphorus, mixed with very fine sand or other substance, is glued to the box in which the matches are contained. It is impossible to light such matches by friction upon any common rough surface, though they at once burst into flame when rubbed upon the phosphorus composition on the box. They can sometimes be lighted

without application to the phosphorus on the box, by drawing them several times with long sweeps over such surfaces as glass, ebony, etc. When they were first introduced into England the use of any other kind in the public buildings was forbidden by a special act of Parliament. Their manufacture has been encouraged in several European countries, and in times past their use has by some governments been enjoined by law. These matches are also called "hygienic," because they can be put into the mouth without danger.

Another kind of safety-match, which has never come into general use, contained the phosphorus at one end and the chlorate of potash at the other. The match is lighted by breaking it in halves and rubbing the two ends together.

In Switzerland, safety-matches are almost the only ones in the market, and in Sweden they are largely manufactured for exportation. A firm in New York imported the latter for many years, but the customs-duty was so high, and the demand so slight, that the business was abandoned. One of the former partners stated that, if the American people would show any desire for the matches, he could furnish them much cheaper than the matches produced in this country, as in Sweden the materials are provided at a very trifling expense. But, as he expressed it, "an American prefers to put his hand into his pocket, take out a match, and strike it on his pantaloons or shoe, to economizing by carrying them around in the box in which he buys them. And you could never get the Irish servants here to use safety-matches unless you had the priest on your side."

Factories for the production of safety-matches were established in New York, Boston, and other places, but they have all failed with the exception of one in Erie, Pennsylvania, which, with the assistance of some of the wax and parlor manufacturers, easily supplies the demand created in this country. Those made by Bryant & May, in England, are also found in the shops here. The great objection to safety-matches seems to be due to the fact that they are so difficult to carry about. In France they are regarded with great disfavor by the population. No one cares to be troubled with an angular box which he must hold in his hand till he has lighted his match; and it is impossible to put the phosphorus compound on a small pocket match-safe, as the surface is not sufficiently great, and the phosphorus soon rubs off.

A gentleman who has been employed in the manufacture of safety-matches expressed it as his opinion that they are the most dangerous matches made. For in the majority of cases, when a match is struck, some of the phosphorus on the box flies off, and, being highly inflammable, if it meets with any combustible substance, it always gives rise to a danger of fire. If lighted where the phosphorus can fall upon the carpet, the result is the same as though the carpet were exposed to the sparks of a fire. There is also a certain degree of temptation offered to those who manufacture these matches. This consists

in putting a small quantity of phosphorus into the heads to make them ignite more easily when brought into contact with the phosphorus on the box. This fraud has actually been carried into effect in Northern Germany, and, although nothing of the kind has been discovered in this country, the fact that it may be will probably increase their unpopularity. The safety-match has certainly had time to win its way, as an old variety of it existed in Switzerland at a period when other parts of the world were still occupied with the flint and steel. It has been claimed for these matches that they are better able to resist moisture than other varieties. The reason, however, is not apparent, as the heads are composed of salts, which are affected by water in the manner of all saline substances. It may be stated as a general rule that those matches are safest which require considerable friction for ignition, and which, when lighted, furnish merely heat enough to kindle the splints. The safest, probably, are those in which a considerable part of the compound is formed of sulphur, as it requires more than usual friction to light them. They are also a quiet match, and in lighting do not scatter any part of the head about. But they kindle slowly, and the sulphurous fumes always render them objectionable. They can also be lighted so conveniently by rubbing them on the wall that a great temptation is held out to servants to disfigure the appearance of a room in this way.

About twenty years ago parlor-matches began to be manufactured and have ever since been growing in favor. No sulphur is used in them, and in their freedom from odor, their convenience and rapidity in lighting, they have a decided advantage over all others. Their noisy explosion is occasioned by chlorate of potash, and may be prevented by substituting nitrate of potash. They are said to be superior to the German match, owing, perhaps, to the fact that they are not coated with varnish. They seem to have attained their greatest popularity in the Western and Southern States, and are used pretty generally among the wealthier classes. Swift & Courtney, who have factories in four different cities, manufacture about 1,500 gross of these daily, and state that the demand for them is constantly increasing. They are nearly half again as expensive as the sulphur-match, and grocers and retail jobbers are inclined to increase their price. There is, however, but a small difference between the cost of matches with sulphur and those in which stearic acid is used, as much more sulphur is required than stearic acid. They partake of the same danger that attends the employment of the safety-match, for if they are tipped too profusely the burning material will scatter to some distance. They take fire easily if any one happens to step upon them, and require to be guarded carefully where there are children. But the danger from their use is not alarming, and insurance companies make but little distinction in their rates between these and others. It is a mistaken idea that the invention of matches has caused much dif-

ference in the number of fires; and, if a certain kind of match is preferred for its convenience, it will not be abandoned because it has an extra element of danger. Fires may result from the overturning of a box by a cat or dog, or by the gnawing of the ends of matches by rats or mice; but these occurrences are exceptional, and rarely happen.

There is said to be only one factory in America where wax-matches are now produced. This has been established within the last few years, is running altogether with French machinery, and is supplying a growing demand. The makers of wax-matches do not come into competition with other manufacturers, but find their custom among those who are attracted especially by the novelty and pleasing appearance of the matches. Their higher cost prevents them from coming into general use, and the fact that there is a monopoly in their manufacture exerts some influence in regard to the price. Great care is taken in the designs for the boxes, and no pains are spared to make them ornamental and attractive. Improvements and new patents are constantly being made in them. The most recent variety has a small hole in the lid which acts as a candlestick. As soon as the match is lighted, the unburned end is inserted in the lid of the box, and an illumination is provided which lasts according to the length of the taper. The usual wax-match gives a fine light, which continues one or two minutes—that is, four or five times as long as wooden matches. This can be increased with their length, and a very respectable impromptu candle may be obtained by the contrivance referred to. Further attractions are provided by arranging the differently-colored heads according to curious and artistic devices. They can be purchased, having a composition resembling the parlor-match, or in the form of safety-matches. All wax-matches must be made so that they will take fire upon slight friction on account of the less resistance afforded by the body of the match; but they are not on this account any more dangerous than the parlor-match. Though sometimes used by smokers, they are not well suited to this purpose, as in lighting a cigar the fatty matter can be detected by the taste.

The Japanese have contributed their stock of curiosities to this department also. They have a variety of paper matches, which burn with a small, scarcely luminous flame, forming, as the combustion advances, a red-hot ball of glowing saline matter. When the match has been partly consumed, a succession of bright sparks shoots out from the head, and gradually a brilliant scintillation is formed similar to that observed in burning a steel spring in oxygen, only much more delicate, the separate sparks branching out in beautiful forms. These matches are composed of carbon, nitre, and sulphur, and there has been no difficulty in imitating them.

Many efforts have been made to construct the heads of matches without phosphorus. There is a match in Germany at the present time in which this result has been reached, but none of the cases dis-

covered seem to be perfectly satisfactory. Dr. Jettel has made a careful examination of the subject, and has arrived at the conclusion that the ingredients prepared to take the place of phosphorus render the match more difficult to ignite, while they are not perfectly harmless, but merely less dangerous. They are more sensitive to moisture; it is more difficult for the maker to secure a satisfactory result; and hence more expensive for the buyer. The Germans in nearly all their matches use a much smaller proportion of phosphorus than is done elsewhere, but the material must yet be found which will take its place entirely.

Accidents may be occasioned by throwing half-burned matches carelessly aside, and allowing them to smoulder near combustible substances. Various chemical solutions have been compounded in which the match is to be soaked, so that, as soon as it is blown out, the fiery mass of carbon will become black. Solutions of this kind are alum, borax, Glauber salts, or Epsom salts. Matches thus prepared are, of course, rendered more expensive.

While so much has been accomplished in the way of getting a quick fire without exertion, there is still room for considerable improvement. A safety-match has yet to be invented which will contain the entire composition on its own head. A water-proof match is desired, but has never been invented. There are firms which represent that they make water-proof matches, and the scientific journals contain from time to time receipts to effect this purpose. But they are not proof to water in the sense in which that is generally understood. Most matches may be put into the mouth or dipped into water for an instant, but none of them will bear a drenching or continued exposure to a moist atmosphere. The safety-match is objectionable for several reasons, the parlor-match from its tendency to scatter about bits of the head, and the sulphur-match from its brimstone-odor.

Matches have been made in which camphor and frankincense were mixed with the paste, and the wood of the match was of cedar, so that an agreeable odor was diffused in getting a light. So the time may come when the fashionable match, in addition to its other excellent qualities, will have such a delicate fragrance that it will be a pleasure merely to light it.

In 1864 the Government required a one-cent stamp to be placed on every package of matches. In anticipation of the tax a large quantity had been manufactured, so that for the first two years the legitimate revenue was not derived. In 1865 the receipts obtained in this manner amounted to about $1,000,000, but since then they have greatly increased, so that the stamp-tax now forms a large part of the cost. In comparison with other branches of business this product of industry probably affords the largest revenue accruing under the excise. Owing to this tax several large firms either failed or retired; and at the present time the manufacturer of sulphur-matches, by the

greatest care and economy, secures but a small margin on his sales. A heavy tax of this kind is liable to defeat its own object, as is exemplified by numerous facts. Thus, in 1865, matches were imported into the United States from New Brunswick, and sold in packages suitable for the retail trade without paying any tax under the internal-revenue law. When, a few years ago in England, a stamp-duty was put upon matches, the opposition was so violent that the attempt had to be abandoned.

In 1872 the French Government, desiring an additional source of revenue, determined to extract it from their matches. They therefore let to a single great company the sole right of making them for twenty years, and agreed to buy up all the old factories and furnish the company with new ones. In return the latter was to pay a fixed rent of $3,200,000 per annum. It was furthermore stipulated that the price of the matches should not be raised, but the company is already accused of treating this as a dead letter. The matches are said to be so bad that they will hardly light, and the peasants, instead of buying them, use a match of home-manufacture, made by steeping hemp in sulphur. Great trouble and expense have been incurred by the state; the company has been despotic and unable to fulfill its obligations; a proposition has been made and rejected on the part of the Government to reduce the rent one-half; and the probabilities are, that the lease will expire before the time agreed upon.

The extent to which the manufacture of matches is carried can be but faintly indicated by means of figures. The demand for them in Great Britain is, on an average, eight daily for each individual; in Belgium, nine per head; and, for Europe and North America, the entire average is six for every inhabitant. To meet this demand matches are produced by the million, and the waxed taper, before division into small pieces, is measured by the mile. It is stated that one pound of phosphorus is sufficient for 1,000,000 matches, though the proportion varies greatly. In France there are consumed for this purpose 70,000 pounds of phosphorus every year. The largest makers are in Austria, two of whom use twenty tons of phosphorus per annum, and produce nearly 45,000,000,000 matches. One firm in New York uses annually 700,000 feet of choice white-pine timber, 100,000 pounds of sulphur, and 150 tons of straw-board for their boxes. Large quantities are exported from the United States to the East and West Indies, China, South America, and other countries. At the census taken here in 1870 there were found to be 75 establishments engaged in the business, and the value of the products for that year was $3,540,000.

THE IMPORT OF PROTOPLASM.[1]

By MICHAEL FOSTER, M. D., F. R. S.

AMONG the simpler organisms known to biologists, perhaps the most simple as well as the most common is that which has received the name of Amœba. There are many varieties of amœba, and probably many of the forms which have been described are, in reality, merely amœbiform phases in the lives of certain animals or plants; but they all possess the same general characters. Closely resembling the white corpuscles of vertebrate blood, they are wholly or almost wholly composed of undifferentiated protoplasm, in the midst of which lies a nucleus, though this is sometimes absent. In many a distinction may be observed between a more solid external layer, or *ectosarc*, and a more fluid granular interior, or *endosarc;* but in others even this primary differentiation is wanting. By means of a continually occurring flux of its protoplasmic substance, the amœba is enabled from moment to moment not only to change its form, but also to shift its position. By flowing round the substances which it meets, it, in a way, swallows them; and, having digested and absorbed such parts as are suitable for food, ejects or rather flows away from the useless remnants. It thus lives, moves, eats, grows, and after a time dies, having been during its whole life hardly anything more than a minute lump of protoplasm. Hence to the physiologist it is of the greatest interest, since in its life the problems of physiology are reduced to their simplest forms.

Now, the study of an amœba, with the help of knowledge gained by the examination of more complex bodies, enables us to state that the undifferentiated protoplasm, of which its body is so largely composed possesses certain fundamental vital properties:

1. It is CONTRACTILE.—There can be little doubt that the changes in the protoplasm of an amœba, which bring about its peculiar "amœboid" movements, are identical in their fundamental nature with those which, occurring in a muscle, cause a contraction; a muscular contraction is essentially a regular, an amœboid movement an irregular flow of protoplasm. The body of the amœba may therefore be said to be contractile.

2. It is IRRITABLE AND AUTOMATIC.—When any disturbance, such as contact with a foreign body, is brought to bear on the amœba at rest, movements result. These are not passive movements, the effects of the push or pull of the disturbing body, and therefore proportionate to the force employed to cause them, but active manifestations of the contractility of the protoplasm; that is to say, the disturbing cause or

[1] From the introduction to M. Foster's "Text-Book of Physiology."

stimulus sets free a certain amount of energy previously latent in the protoplasm, and the energy set free takes on the form of movement. Any living matter which, when acted on by a stimulus, thus suffers an explosion of energy, is said to be "irritable." The irritability may, as in the amœba, lead to movement; but in some cases no movement follows the application of the stimulus to irritable matter, the energy set free by the explosion taking on some other form (heat, etc.) than movement. Thus a substance may be irritable and yet not contractile, though contractility is the most common manifestation of irritability.

The amœba (except in its prolonged quiescent stage) is rarely at rest. It is almost continually in motion. The movements cannot always be referred to changes in surrounding circumstances acting as stimuli; in many cases the energy is set free in consequence of internal changes, and the movements which result are called spontaneous or automatic[1] movements. We may, therefore, speak of the protoplasm of the amœba as being irritable and automatic.

3. It is receptive and assimilative.—Certain substances serving as food are received into the body of the amœba, and, being there in large measure dissolved, become part and parcel of the body of the amœba—become, in fact, fresh protoplasm.

4. It is metabolic and secretory.—*Pari passu* with the reception of new material, there is going on an ejection of old material, for the increase of the amœba by the addition of food is not indefinite. In other words, the protoplasm is continually undergoing chemical change (metabolism), room being made for the new protoplasm by the breaking up of the old protoplasm into products which are cast out of the body and got rid of. These products of metabolic action have, in all probability, subsidiary uses. Some of them, for instance, we have reason to think, are of value in the solution and preliminary changes of the raw food mechanically introduced into the body of the amœba; and hence are retained within the protoplasm for some little time. Such products are generally spoken of as "secretions." Others, which pass more rapidly away, are generally called "excretions." The distinction between the two is an unimportant and frequently accidental one. The energy expended in the movements of the amœba is supplied by the chemical changes going on in the protoplasm by the breaking up of bodies possessing much latent energy into bodies possessing less. Thus the metabolic changes which the food undergoes in passing through the protoplasm of the amœba (as distinguished

[1] This word has recently acquired a meaning almost exactly opposite to that which it originally bore, and an automatic action is now by many understood to mean nothing more than an action produced by some machinery or other. In this work I use it in the older sense, as denoting an action of a body, the causes of which appear to lie in the body itself. It seems preferable to "spontaneous," inasmuch as it does not necessarily carry with it the idea of irregularity, and bears no reference to a "will."

from the undigested stuff mechanically lodged for a while in the body) are of three classes: those preparatory to and culminating in the conversion of the food into protoplasm; those concerned in the discharge of energy; and those tending to economize the immediate products of the second class of changes by rendering them more or less useful for the first.

5. It is respiratory.—Taken as a whole, the metabolic changes are preëminently processes of oxidation. One article of food—i. e., one substance taken into the body, viz., oxygen—stands apart from all the rest; and one product of metabolism peculiarly associated with oxidation—viz., carbonic acid—stands also somewhat apart from all the rest. Hence, the assumption of oxygen and the excretion of carbonic acid, together with such of the metabolic processes as are more especially oxidative, are frequently spoken of together as constituting the respiratory processes.

6. It is reproductive.—The individual amœba represents a unit. This unit, after a longer or shorter life, having increased in size by the addition of new protoplasm in excess of that which it is continually using up, may by fission (or by other means) resolve itself into two (or more) parts, each of which is capable of living as a fresh unit or individual.

Such are the fundamental vital qualities of the protoplasm of an amœba; all the facts of the life of an amœba are manifestations of these protoplasmic qualities in varied sequence and subordination. The higher animals, we learn from morphological studies, are in reality groups of amœbæ peculiarly associated together. All the physiological phenomena of the higher animals are similarly the results of these fundamental qualities of protoplasm peculiarly associated together. The dominant principle of this association is the physiological division of labor corresponding to the morphological differentiation of structure. Were a larger or "higher" animal to consist simply of a colony of undifferentiated amœbæ, one animal differing from another merely in the number of units making up the mass of its body, without any differences between the individual units, progress of function would be an impossibility. The accumulation of units would be a hindrance to welfare rather than a help. Hence, in the evolution of living beings through past times, it has come about that in the higher animals (and plants) certain groups of the constituent amœbiform units or cells have, in company with a change in structure, been set apart for the manifestation of certain only of the fundamental properties of protoplasm, to the exclusion or at least to the complete subordination of the other properties.

These groups of cells, thus distinguished from each other, at once by the differentiation of structure and by the more or less marked exclusiveness of structure, receive the name of "tissues." Thus, the units of one class are characterized by the exaltation of the contrac-

tility of their protoplasm, their automatism, metabolism, and reproduction, being kept in marked abeyance. These units constitute the so-called muscular tissue. Of another tissue—viz., the nervous—the marked features are irritability and automatism, with an almost complete absence of contractility and a great restriction of the other qualities. In a third group of units, the activity of the protoplasm is largely confined to the chemical changes of secretion, contractility and automatism (as manifested by movement) being either absent or existing to a very slight degree. Such a secreting tissue, consisting of epithelium-cells, forms the basis of the mucous membrane of the alimentary canal. In the kidney, the substances secreted by the cells, being of no further use, are at once ejected from the body. Hence the renal tissue may be spoken of as excretory. In the epithelium-cells of the lungs, the protoplasm plays an altogether subordinate part in the assumption of oxygen and the excretion of carbonic acid. Still, we may, perhaps, be permitted to speak of the pulmonary epithelium as a respiratory tissue.

In addition to these distinctly secretory or excretory tissues, there exist groups of cells specially reserved for the carrying on of chemical changes, the products of which are neither cast out of the body nor collected in cavities for digestive or other uses. The work of these cells seems to be of an intermediate character: they are engaged either in elaborating the material of food that it may be the more easily assimilated, or in preparing used-up material for final excretion. They receive their material from the blood, and return their products back to the blood. They may be called the metabolic tissues *par excellence*. Such are the fat-cells of adipose tissue, the hepatic cells (as far as the work of the liver other than the secretion of bile is concerned), and, in general, the blood.

Each of the various units retains, to a greater or less degree, the power of reproducing itself, and the tissues generally are capable of regeneration in kind. But neither units nor tissues can reproduce other parts of the organism than themselves, much less the entire organism. For the reproduction of the complex individual, certain units are set apart in the form of ovary and testis. In these, all the properties of protoplasm are distinctly subordinated to the work of growth.

Lastly, there are certain groups of units—certain tissues which are of use in the body of which they form a part, not by reason of their manifesting any of the fundamental qualities of protoplasm, but on account of the physical and mechanical properties of certain substances which their protoplasm has been able, by virtue of its metabolism, to manufacture and to deposit. Such tissues are bone, cartilage, connective tissue in large part, and the greater portion of the skin.

We may, therefore, consider the complex body of a higher animal

as a compound of so many tissues, each tissue corresponding to one of the fundamental qualities of protoplasm, to the development of which it is specially devoted by the division of labor. It must, however, be remembered, that there is a distinct limit to the division of labor. In each and every tissue, in addition to its leading quality, there are more or less pronounced remnants of all the other protoplasmic qualities. Thus, though we may call one tissue *par excellence* metabolic, all the tissues are, to a greater or less extent, metabolic. The energy of each, whatever be its particular mode, has its source in the breaking up of the protoplasm. Chemical changes, including the assumption of oxygen and the production, complete or partial, of carbonic acid, and therefore also entailing a certain amount of secretion and excretion, must take place in each and every tissue. And so with all the other fundamental properties of protoplasm; even contractility, which, for obvious mechanical reasons, is soonest reduced where not wanted, is present in many other tissues besides muscle. And it need hardly be said that each tissue retains the power of assimilation. However thoroughly the material of food be prepared by digestion and subsequent metabolic action, the last stages of its conversion into living protoplasm are effected directly and alone by the tissue of which it is about to form a part.

Bearing this qualification in mind, we may draw up a physiological classification of the body into the following fundamental tissues:

1. The eminently contractile: the muscles.
2. The eminently irritable and automatic: the nervous system.
3. The eminently secretory or excretory: digestive, urinary, and pulmonary, etc., epithelium.
4. The eminently metabolic: fat-cells, hepatic cells, lymphatic and ductless glands.
5. The reproductive: ovary, testis.
6. The indifferent or mechanical: cartilage, bone, etc.

All these separate tissues, with their individual characters, are, however, but parts of one body; and in order that they may be true members working harmoniously for the good of the whole, and not isolated masses, each serving its own ends only, they need to be bound together by coördinating bonds. Some means of communication must necessarily exist between them. In the mobile, homogeneous body of the amœba, no special means of communication are required. Simple diffusion is sufficient to make the material gained by one part common to the whole mass, and the native protoplasm is physiologically continuous, so that an explosion set up at any one point is immediately propagated throughout the whole irritable substance. In the higher animals the several tissues are separated by distances far too great for the slow process of diffusion to serve as a sufficient means of communication, and their primary physiological continuity is broken by their being imbedded in masses of formed material, the product of

the indifferent tissues, which, being devoid of irritability, present an effectual barrier to the propagation of molecular explosions. It thus becomes necessary that, in the increasing complexity of animal forms, the process of differentiation should be accompanied by a corresponding integration, that the isolated tissues should be made a whole by bonds uniting them together. These bonds, moreover, must be of two kinds.

In the first place, there must be a ready and rapid distribution and interchange of material. The contractile tissues must be abundantly supplied with material best adapted by previous elaboration for direct assimilation, and the waste products arising from their activity must be at once carried away to the metabolic or excretory tissues. And so with all the other tissues. There must be a free and speedy intercourse of material between each and all. This is at once and most easily effected by the regular circulation of a common fluid, the blood, into which all the elaborated food is discharged, from which each tissue seeks what it needs, and to which each returns that for which it has no longer any use. Such a circulation of fluid being in large measure a mechanical matter, needs a machinery, and calls forth an expenditure of energy. The machinery is supplied by a special construction of the primary tissues, and the energy is arranged for by the presence among these of contractile and irritable matter. Thus, to the fundamental tissues there is added, in the higher animals, a vascular bond in the shape of a mechanism of circulation.

In the second place, no less important than the interchange of material is the interchange of energy. In the amœba, the irritable surface is physiologically continuous with the more internal protoplasm, while each and every part of the body has automatic powers. In the higher animals portions only of the skin remain as eminently irritable or sensitive structures, while automatic actions are chiefly confined to a central mass of irritable or nervous matter. Both forms of irritable matter are separated by long tracts of indifferent material from those contractile tissues through which they chiefly manifest the changes going on in themselves. Hence the necessity for long strands of eminently irritable tissue to connect the skin and contractile tissues, as well with each other as with the automatic centres. Similar strands are also needed, though perhaps less urgently, to connect the other tissues with these and with each other. To the vascular bond there must be added an irritable bond, along the strands of which impulses, set up by changes in one or another part, may travel in determinate courses for the regulation of the energy of distant spots. In other words, part of the irritable tissues must be specially arranged to form a coördinating nervous system.

Still further complications have yet to be considered. In the life of a minute homogeneous amœba, possessing no special form or structure, there is little scope for purely mechanical operations. As, how-

ever, we trace out the gradual development of the more complex animal forms, we see coming forward into greater and greater prominence the arrangement of the tissues in definite ways to secure mechanical ends. Thus the entire body acquires particular shapes, and parts of the body are built up into mechanisms, the actions of which are to the advantage of the individual. Into the composition of these mechanisms, or "organs," the active, fundamental tissues, as well as the passive or indifferent tissues, enter; and the working of each mechanism, the function of each organ is dependent partly on the mechanical conditions offered by the passive elements, partly on the activity of the active elements. The vascular mechanism, of which we have just spoken, is such a mechanism. Similarly, the urgent necessity for the access of oxygen to all parts of the body has given rise to a complicated respiratory mechanism; and the needs of copious alimentation, to an alimentary or digestive mechanism.

Further, inasmuch as muscular movement is one of the chief ends, or the most important means to the chief ends of animal life, we find the animal body abounding in motor mechanisms, in which the prime mover is muscular contraction, while the machinery is supplied by complicated arrangements of muscles with such indifferent tissues as bone, cartilage, and tendon. In fact, the greater part of the animal body is a collection of muscular machines, some serving for locomotion, others for special manœuvres of particular members and parts, others as an assistance to the senses, and yet others for the production of voice, and, in man, of speech.

Lastly, the simple automatism of the amœba, with its simple responses to external stimuli, is replaced in the higher animals by an exceedingly complex volition, affected in multitudinous ways by influences from the world without; and there is a correspondingly complex central nervous system. And here we meet with a new form of differentiation unknown elsewhere. While the contractility of the amœbal protoplasm differs at the most but slightly from the contractility of the vertebrate striated muscle, there is an enormous difference between the simple irritability of the amœba and the complex action of the vertebrate nervous system. Excepting the nervous or irritable tissues, the fundamental tissues have in all animals exactly the same properties, being, it is true, more acute and perfect in one than in another, but remaining fundamentally the same. The elementary muscular fibre of a mammal is at most a mass of but slightly differentiated protoplasm, forming a whole physiologically continuous, and in no way constituting a mechanism. Each fibre is a counterpart of all others; and the muscle of one animal differs from that of another in such particulars only as are wholly subordinate. In the nervous tissues of the higher animal, on the contrary, we find properties unknown to those of the lower ones; and, in proportion as we ascend the scale, we observe an increasing differentiation of the nervous sys-

tem into unlike parts. Thus we have what does not exist in any other tissue—a mechanism of nervous tissue itself, a central nervous mechanism of complex structure and complex function, the complexity of which is due not primarily to any mechanical arrangement of its parts, but to the further differentiation of that fundamental quality of irritability and spontaneity which belongs to all irritable tissues and to all native protoplasm.

In the following pages I propose to consider the facts of physiology very much according to the views which have been just sketched out. The fundamental properties of most of the elementary tissues will first be reviewed, and then the various special mechanisms. It will be found convenient to introduce early the account of the vascular mechanism, and of its nervous, coördinating mechanism, while the mechanisms of respiration and alimentation will be best considered in connection with the respiratory and secretory tissues. The description of the purely motor mechanisms will be brief, and, save in a few instances, confined to a statement of general principles. The special functions of the central nervous system, including the senses, must of necessity be considered by themselves. The tissues and mechanism of reproduction naturally form the subject of the closing chapter.

THE ELECTRIC CANDLE.[1]

By ALFRED NIAUDET.

PUBLIC attention has been directed to Jabloshkoff's system of electrical lighting by the use that has been made of it at the Magasins du Louvre, in illuminating a hall recently opened. During the past year this invention was brought under the notice of the public by a communication addressed to the Paris Academy of Sciences, and by an experiment made before the Physical Society. The readers of *La Nature* are acquainted with the usual methods of producing electrical light, and we here again explain their general principles, with a view to render more intelligible the comparisons we propose to make.

Two carbon-points, borne on suitable metallic supports, are arranged in one line, with their tips in contact. An electric current of high intensity is made to pass into them; they may become heated, but they will not give out light unless they be separated by a little distance from each other. On separating them, by the hand or otherwise, the voltaic arc appears and gives out a very strong light. This light persists, provided the carbons are a few millimetres apart; but,

[1] Translated from the French by J. Fitzgerald, A. M.

as the carbons waste away, the distance between their tips becomes greater, the voltaic arc is lengthened, and soon the light goes out, unless the points are again brought near to each other. Hence it is seen that this rudimentary apparatus cannot support the electric light for over a few minutes, and some contrivance had to be devised for approximating the carbons in proportion as they waste away, and for keeping them a very small distance apart. This is done in the lamps devised by Serrin, Foucault, and others.

When the source of electricity is a pile or a magneto-electric machine with continuous currents, like Gramme's machine, a new difficulty is met with; for here the two carbons are consumed unequally, the positive one wasting about twice as fast as the negative. On the other hand, machines with alternately reversed currents present this peculiarity, that in them the waste of the two carbons is equal.

To whatever grade of perfection such lamps may have attained, they undoubtedly labor under sundry disadvantages. Their mechanism is delicate, and necessitates very great care on the part of those who operate them. It is not very easy to regulate them. Their main bulk, being situated beneath the luminous point, casts an objectionable shadow. As usually constructed, their size is such that they cannot work over three hours without having fresh carbons put in, and this renewal of the carbons necessitates either a temporary interruption of the lighting or else the keeping of an extra machine, which involves an increased outlay of money. Finally, the price of such machines is pretty high, and can hardly be reduced.

The very great progress made during the last few years in the construction of magneto-electric machines has made more evident the imperfections of the regulating apparatus.

Such was the condition of things when a Russian engineer, M. Jabloshkoff, succeeded in dispensing altogether with the mechanism of electrical lamps. Let us see how this lucky inventor has succeeded in overcoming the difficulties that successively arose before him.

First of all, he sets out with the idea that the carbons must be placed side by side, so as to consume them simultaneously without having continually to regulate their respective positions, just as in stearine-candles the wick is consumed in proportion to the consumption of stearine. The first requisite is, that the voltaic arc shall be produced only at the tips of the carbons. For this purpose it is sufficient to place between the two carbons a strip of glass, kaolin, or any other insulating substance, somewhat wider than the carbons, and not reaching to their tips. It might be supposed that this insulating substance, while separating the two carbons, would soon form an impassable barrier between the one and the other, and extinguish the voltaic arc by requiring it to make too great a span. But such is not the case; the high temperature of the voltaic arc is

sufficient to melt and even to vaporize glass or kaolin, and thus the insulating septum between the carbons wears away simultaneously with them.

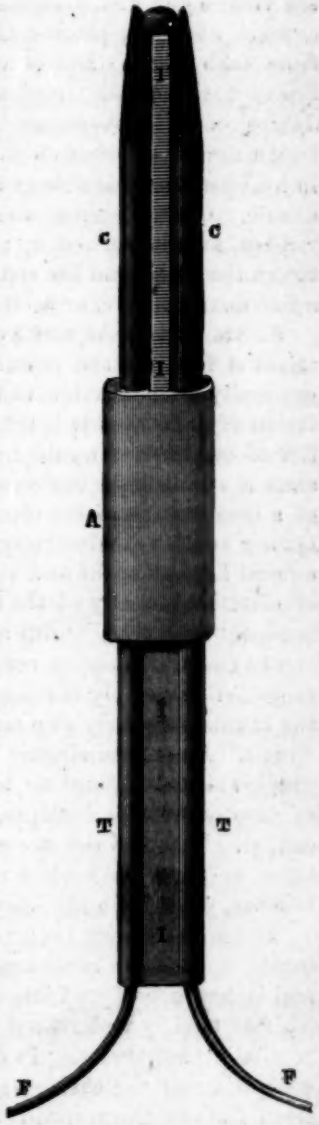
If the source of electricity gives constant currents, then, inasmuch as the carbons wear unequally, one wasting more rapidly than the other, the distance between the points will become too great, and the light will be extinguished. To overcome this difficulty, we have only to make the carbon that burns most rapidly twice as thick as the other.

It is true that hitherto the electric candle has worked better with magneto-electric machines giving alternating currents, than with piles or Gramme machines; in the former case the carbons wear away equally, and are of the same thickness.

To complete the description of Jabloshkoff's apparatus, we have to add that each carbon is socketed in a brass tube, connected with a wire coming from the source of electricity. These two tubes are attached to each other in various ways, according to the applications had in view; the one essential precaution is, to take care that they do not come into contact with each other.

The name candle has been very happily applied to this simple apparatus; it is, indeed, a candle with two wicks burning side by side, and which lower their luminous point as combustion goes on. One interesting peculiarity it possesses, namely, that the luminous point can be turned downward, so that there is nothing to throw a shadow. Its light may be modified by the use of opal or ground-glass shades.

How the Candle is lighted.—One of the principal advantages of Serrin's lamp is, that it can be lighted from a distance. The lamp is made ready, say, in the morning, and, when night comes, all that is required is to admit the elec-



Jabloshkoff's Electric Candle (actual size).—*C C*, carbon-points of gas-coke; *I I I I*, insulating substance; *T T*, tubes holding the carbon-points; *A*, socket of asbestos holding the system together; *F F*, copper wires conveying the electric current.

tric current, and light is instantaneously produced. At first Jabloshkoff lighted his candle directly by supporting on the tips of the two wicks a piece of charcoal which he soon afterward removed; thus the voltaic arc was produced as in electric lamps, by beginning with contact, and then placing the two carbons at the required distance from each other. But it was necessary to devise some method for lighting the candle from a distance, and this fresh difficulty M. Jabloshkoff has overcome by a very simple device. He places between the two carbons a little bit of graphite, of the diameter used in lead-pencils; this acts as a conductor between the two wicks of the candle. On the current entering it, the bit of graphite soon becomes red-hot, and is burned up; there is then a break of continuity between the wicks, and the electric arc is produced. Instead of graphite, a fine metallic wire, or a bit of lead, can be used.

Relighting.—As we have stated, the insulating strip between the wicks is fused at the points near the voltaic arc, and so disappears gradually in proportion to the waste of the carbon-points. But this fusion of the insulator is attended with another consequence that but few of our readers would have anticipated. That which in its solid state is an insulator becomes in its liquid state a conductor, and allows of a longer span of the electric arc than could be had in the free air. Owing to this conductivity of the strip of kaolin, the circuit may be opened for a moment and the candle lighted again without any need of resorting to any of the contrivances already described under the head of "Lighting." But after a certain length of time, as the substance cools, it loses its conductivity, and then the candle cannot be relighted by simply closing the circuit again. We may extinguish the candle for nearly two seconds, and relight it by simply closing the circuit. Hence the electric candle may be used for transmitting telegraphic signals according to the Morse alphabet, by means of flashes of greater or less duration, divided by longer or shorter periods of eclipse. For such use the candle is better adapted than the electric lamp, as it is more readily relighted, producing at once a perfect voltaic arc, whereas in the lamp the arc is produced gradually.

Division of the Light.—Hitherto a separate pile, or a separate machine, has been necessary for the production of each electric light, and it has been found impossible to place two lamps in one circuit. This is readily understood when we consider the mechanism of the regulating apparatus. In electric lamps the approximation and the separating of the carbons are controlled by an electro-magnet, which itself follows the variations of resistance in the circuit produced by changes in the length of the voltaic arc. As the arc lengthens the resistance of the circuit is increased, and the electro-magnet is weakened, and allows the carbons to approximate. It is easily understood that if there are two lamps and two voltaic arcs in one circuit, and if only one of these arcs is lengthened, both electro-magnets will act and

shorten the two voltaic arcs. The consequence is, that the second lamp will have its proper working interfered with, while the first alone should have been regulated. In other words, the solidarity of the two apparatuses will tend to produce in each unnecessary changes of regulation that will constantly result in causing the system of lamps to work badly. But with the candle there is nothing of this kind, and, provided that the source of electricity possesses sufficient tension to produce the voltaic arcs, many may stand in the same circuit. In the Magasins du Louvre we have seen in some instances four lights, in others three, produced by a single machine. The sequel will show whether we can reasonably expect to see even a greater division of the electric light, and whether this invention may not have still further applications.—*La Nature.*

THE STATUS OF WOMEN AND CHILDREN.

By HERBERT SPENCER.

I.

PERHAPS in no way is the moral progress of mankind more clearly shown than by contrasting the position of women among savages with their position among the most advanced of the civilized: at the one extreme a treatment of them cruel to the utmost degree bearable; and at the other extreme a treatment which, in certain directions, gives them precedence over men.

The only limit to the brutality women are subjected to by men of the lowest races is the inability to live and propagate under greater. Clearly, ill-usage, under-feeding, and overworking, may be pushed to an extent which, if not immediately fatal to the women, incapacitates them for rearing children enough to maintain the population; and disappearance of the society follows. Both directly and indirectly such excess of harshness disables a tribe from holding its own against other tribes; since, besides greatly augmenting the mortality of children, it causes inadequate nutrition, and therefore imperfect development, of those which survive. But, short of this, there is at first no check to the tyranny which the stronger sex exercises over the weaker. Stolen from another tribe, and perhaps made insensible by a blow that she may not resist; not simply beaten, but speared about the limbs, when she displeases her savage owner; forced to do all the drudgery and bear all the burdens, while she has to care for and carry about her children; and feeding on what is left after the man has done: the woman's sufferings are carried as far as consists with survival of herself and her offspring.

It seems not improbable that, by its actions and reactions, this

treatment makes these relations of the sexes difficult to change; since chronic ill-usage produces physical inferiority, and physical inferiority tends to exclude those feelings which might check ill-usage. Very generally among the lower races the females are even more unattractive in aspect than the males. It is remarked of the Puttooahs, whose men are diminutive and whose women are still more so, that "the men are far from being handsome, but the palm of ugliness must be awarded to the women. The latter are hard-worked and apparently ill-fed." Again, of the inhabitants of the Corea, Gutzlaff says: "The females are very ugly, while the male sex is one of the best formed of Asia . . . . women are treated like beasts of burden; wives may be divorced under the slightest pretense." And for the kindred contrast habitually found, a kindred cause may habitually be assigned; the antithetical cases furnished by such uncivilized peoples as the Calmucks and Kirghiz, whose women, less hardly used, are better looking, yielding additional evidence.

We must not, however, conclude, as at first sight seems proper, that this low *status* of women among the rudest peoples is caused by a callous selfishness existing in the males and not equally present in the females. When we learn that where torture of enemies is the custom, the women outdo the men—when we read of the cruelties perpetrated by the two female Dyak chiefs described by Rajah Brooke, or of the horrible deeds which Winwood Reade narrates of a bloodthirsty African queen—we are shown that it is not lack of will but lack of power which prevents primitive women from displaying natures equally brutal with those of primitive men. A savageness common to the two necessarily works out the results we see under the conditions. Let us look at these results more closely.

Certain anomalies may first be noticed. Even among the rudest men, whose ordinary behavior to their women is of the worst, predominance of women is not unknown. Snow says of the Fuegians that he has "seen one of the oldest women exercising authority over the rest of her people;" and Mitchell says of the Australians that old men and even old women exercise great authority. Then we have the fact that among various peoples who hold their women in degraded positions, there nevertheless occur female rulers; as among the Batta people in Sumatra, as in Madagascar, and as in the above-named African kingdom. Possibly this anomaly results from the system of descent in the female line. For though, under that system, property and power usually devolve upon a sister's male children, yet as, occasionally, there is only one sister, and she has no male children, the elevation of a daughter may sometimes result. Even as I write, I find, on looking into the evidence, a significant example. Describing the Haidahs of the Pacific States, Bancroft says: "Among nearly all of them rank is nominally hereditary, for the most part by the female line. . . . Females often possess the right of chieftainship."

But leaving these exceptional facts, and looking at the average facts, we find these to be just such as the greater strength of men must produce, during stages in which the race has not yet acquired the higher sentiments. Numerous examples, already cited, show that at first women are regarded by men simply as property, and continue to be so regarded through several later stages: they are valued as domestic cattle. A Chippewayan chief said to Hearne:

> "Women were made for labor; one of them can carry, or haul, as much as two men can do. They also pitch our tents, make and mend our clothing, keep us warm at night; and, in fact, there is no such thing as traveling any considerable distance, in this country, without their assistance."

And this is the conception usual not only among peoples so low as these, but among peoples considerably advanced. To repeat an illustration quoted from Barrow, the woman "is her husband's ox, as a Caffre once said to me—she has been bought, he argued, and must therefore labor;" and to the like effect is Shooter's statement that a Caffre who kills his wife "can defend himself by saying, 'I have bought her once for all.'"

As implied in such a defense, the obtainment of wives by abduction or by purchase maintains this relation of the sexes. A woman of a conquered tribe, not killed but brought back alive, is naturally regarded as an absolute possession; as is also one for whom a price has been paid. Commenting on the position of women among the Chibchas, Simon writes, "I think the fact that the Indians treat their wives so badly and like slaves is to be explained by their having bought them." Fully to express the truth, however, we must rather say that the state of things, moral and social, implied by the traffic in women, is the original cause; since the will and welfare of a daughter are as much disregarded by the father who sells her as by the husband who buys her. The accounts of these transactions, in whatever society occurring, show this. Describing the sale of his daughter by a Mandan, Catlin says it is "conducted on his part as a mercenary contract entirely, where he stands out for the highest price he can possibly command for her." Of the ancient Yucatanese we read that "if a wife had no children, the husband might sell her, unless her father agreed to return the price he had paid." In East Africa, a girl's "father demands for her as many cows, cloths, and brass-wire bracelets, as the suitor can afford. . . . The husband may sell his wife, or, if she be taken from him by another man, he claims her value, which is ruled by what she would fetch in the slave-market." Of course, where women are exchangeable for oxen or other beasts, they are regarded as equally without personal rights.

The degradation they are subject to during phases of human evolution in which egoism is unchecked by altruism, is, however, most vividly shown by the transfer of a deceased man's wives to his rela-

tives along with other property. Sundry examples of this have been given; and many others might be added. Smith says of the Mapuchès that "a widow by the death of her husband becomes her own mistress, unless he may have left grown-up sons by another wife, in which case she becomes their common concubine, being regarded as a chattel naturally belonging to the heirs of the estate."

Thus recognizing the truth that as long as women continue to be stolen or bought, their human individualities are ignored, let us observe the division of labor that results between the sexes; determined partly by this unqualified despotism of men and partly by the limitations which certain incapacities of women entail.

The slave-class in a primitive society consists of the women; and the earliest division of labor is that which arises between them and their masters. For a long time no other division of labor exists. Of course nothing more is to be expected among such low, wandering groups as Tasmanians, Australians, Fuegians, Andamanese, Bushmen. Nor do we find any advance in this respect made by the higher hunting races, such as the Comanches, Chippewas, Dakotas, etc.

Of the occupations thus divided, the males put upon the females whatever these are not disabled from doing by inadequate strength, or agility, or skill. While the men among the now-extinct Tasmanians added to the food only that furnished by the kangaroos they chased, the women climbed trees for opossums, dug up roots with sticks, groped for shell-fish, dived for oysters, and fished, in addition to looking after their children; and there now exists a kindred apportionment among the Fuegians, Andamanese, Australians. Where the food consists wholly or mainly of the greater mammals, the men catch and the women carry. We read of the Chippewas that "when the men kill any large beast, the women are always sent to bring it to the tent;" of the Comanches, that the women "often accompany their husbands in hunting—he kills the game, they butcher and transport the meat, dress the skins, etc.;" of the Esquimaux, that when the man has "brought his booty to land, he troubles himself no further about it; for it would be a stigma on his character, if he so much as drew a seal out of the water." Though, in these cases, an excuse made is that the exhaustion caused by the chase is great, yet, when we read that the Esquimaux women, excepting the woodwork, "build the houses and tents, and though they have to carry stones almost heavy enough to break their backs, the men look on with the greatest insensibility, not stirring a finger to assist them," we cannot accept the excuse as adequate. Further, it is the custom with these low races, nomadic or semi-nomadic in their habits, to give the females the task of transporting the baggage. A Tasmanian woman often had piled on all the other burdens she carried when tramping, "sundry spears and waddies not required for present service;" and the like

happens with races considerably higher, both semi-agricultural and pastoral. A Damara's wife "carries his things when he moves from place to place." When the Tupis migrate, all the household stock is taken to the new abode by the females: "The husband only took his weapons, and the wife," says Marcgraff, "is loaded like a mule." Similarly, enumerating the labors of wives among the aborigines of South Brazil, Spix and Martius say, "They are also the beasts of burden;" and in like manner Dobrizhoffer writes, "The luggage being all committed to the women, the Abipones travel armed with a spear alone, that they may be disengaged to fight or hunt, if occasion requires." Doubtless the reason indicated in the last extract is a partial defense for this practice, so general with savages when traveling; since, liable as they are to be at any moment surprised by ambushed enemies, fatal results would happen were the men not ready to fight on the instant. And possibly knowledge of this may join the force of custom in making the women themselves uphold the practice, as they do.

On ascending to societies partially or wholly settled, and a little more complex, we begin to find considerable diversities in the division of labor between the sexes. Usually the men are the builders, but not always: the women erect the huts among the Bechuanas, Caffres, Damaras, as also do the women of the Outanatas, New Guinea; and sometimes it is the task of women to cut down trees, though nearly always this business falls to the men. Anomalous as it seems, we are told of the Coroados that "the cooking of the dinner, as well as keeping in the fire, is the business of the men;" and the like happens in Samoa: "The duties of cooking devolve on the men"—not excepting the chiefs. Mostly among the uncivilized and semi-civilized, trading is done by the men, but not always. In Java, according to Raffles, "the women alone attend the markets and conduct all the business of buying and selling." So, too, according to Astley, in Angola the women "buy, sell, and do all other things which the men do in other countries, while their husbands stay at home, and employ themselves in spinning, weaving cotton, and such like effeminate business." In ancient Peru there was a like division: men did the spinning and weaving, and women the field-work. Again, according to Bruce, in Abyssinia "it is infamy for a man to go to market to buy anything. He cannot carry water or bake bread; but he must wash the clothes belonging to both sexes, and, in this function, the women cannot help him." And Petherick says that among the Arabs "the females repudiate needlework entirely, the little they require being performed by their husbands and brothers."

From a general survey of the facts, multitudinous and heterogeneous, thus briefly indicated, the only definite conclusion appears to be that men monopolize the occupations requiring both strength and agility always available—war and the chase. Leaving undiscussed the relative fitness of women at other times for fighting enemies and

pursuing wild animals, it is clear that during the child-bearing period their ability to do either of these things is so far interfered with, both by pregnancy and by the suckling of infants, that they are practically excluded from them. Though the Dahomans, with their army of amazons, show us that women may be warriors, yet the instance proves that women can become warriors only by being practically unsexed; for, nominally wives of the king, they are celibate, and any unchastity is fatal. But omitting those activities for which women are, during large parts of their lives, physically incapacitated, or into which they cannot enter in considerable numbers without fatally diminishing population, we cannot define the division of labor between the sexes, further than by saying that, before civilization begins, the stronger sex forces the weaker to do all the drudgery; and that along with social advance the apportionment, somewhat mitigated in character, becomes variously specialized under varying conditions.

As bearing on the causes of the mitigation, presently to be dealt with, we may here note that women are better treated where circumstances lead to likeness of occupations between the sexes. Schoolcraft remarks of the Chippewayans that "they are not remarkable for their activity as hunters, which is owing to the ease with which they snare deer and spear fish, and these occupations are not beyond the strength of their old men, women, and boys;" and then he also says that "though the women are as much in the power of the men as other articles of their property, they are always consulted, and possess a very considerable influence in the traffic with Europeans, and other important concerns." We read, too, in Lewis and Clarke, that "among the Clatsops and Chinnooks, who live upon fish and roots, which the women are equally expert with the men in procuring, the former have a rank and influence very rarely found among Indians. The females are permitted to speak freely before the men, to whom, indeed, they sometimes address themselves in a tone of authority." Then, again, Bancroft tells us that "in the province of Cueba women accompany the men, fighting by their side and sometimes even leading the van;" and of this same people he also quotes Wafer as saying that "their husbands are very kind and loving to them. I never knew an Indian to beat his wife, or give her any hard words." A kindred meaning appears traceable in a fact supplied by the Dahomans, among whom, sanguinary and utterly unfeeling as they are, the participation of women with men in war goes along with a social *status* much higher than usual; for Burton tells us that in Dahomey "the woman is officially superior, but under other conditions she still suffers from male arrogance."

A probable further cause of improvement in the treatment of women may here be noted: I refer to the obtaining of wives by services rendered, instead of by property paid. The practice which Hebrew tradition acquaints us with in the case of Jacob, proves to be a

widely-diffused practice. It is general with the Bhils, Gonds, and Hill-tribes of Nepaul; it obtained in Java before Mohammedanism was introduced; it was common in ancient Peru and Central America; and among sundry existing American races it still occurs. Obviously, a wife long labored for is likely to be more valued than one stolen or bought. Obviously, too, the period of service, during which the betrothed girl is looked upon as a future spouse, affords room for the growth of some feeling higher than the merely instinctive—initiates something approaching to the courtship and engagement of civilized peoples. But the facts chiefly to be noted are—1. That this modification, practicable with difficulty among the rudest predatory tribes, becomes gradually more practicable as there arise established industries affording spheres in which services may be rendered; and, 2. That it is the poorer members of the community, occupied in labor and unable to buy their wives, among whom the substitution of service for purchase will most prevail; the implication being that this higher form of marriage into which the industrial class is led, develops along with the industrial type.

And now we are introduced to the general question, "What connection is there between the *status* of women and the type of social organization?"

A partial answer to this question was reached when we concluded that there are natural associations between militancy and polygyny, and between industrialness and monogamy. For, as polygyny implies a low position of women, while monogamy is a prerequisite to a high position of women, it follows that decrease of militancy and increase of industrialness are general concomitants of a rise in their position. This conclusion appears also to be congruous with the fact just observed. The truth that, among peoples otherwise inferior, the position of women is relatively good where their occupations are nearly the same as those of men, seems allied to the wider truth that their position becomes good in proportion as warlike activities are replaced by industrial activities; since, when the men fight while the women work, the difference of occupation is greater than when both are engaged in productive labors, however unlike such labors may be in kind. From general reasons for alleging this connection, let us now pass to more special reasons.

As it needed no marshaling of evidence to prove that the chronic militancy characterizing low, simple tribes, habitually goes with polygyny, so it needs no marshaling of evidence to prove that along with this chronic militancy there goes a brutal treatment of women. It will suffice if we here glance at the converse cases of simple tribes which are exceptional in their industrialness, and at the same time exceptional in the higher positions held by women among them. Even the rude Todas, low as are the sexual relations implied by their com-

bined polyandry and polygyny, and little developed as is the industry implied by their semi-settled cow-keeping life, furnish evidence: to the men and boys are left all the harder kinds of work, and the wives "do not even step out-of-doors to fetch water or wood, which .... is brought to them by one of their husbands;" and this trait goes along with the trait of peacefulness and entire absence of the militant type of social structure. Striking evidence is furnished by another of the Hill-tribes—the Bodo and Dhimáls. We have seen that, among peoples in low stages of culture, these furnish a marked case of non-militancy, absence of the political organization which militancy develops, absence of class-distinctions, and presence of that voluntary exchange of services implied by industrialism; and of them, monogamous as already shown, we read: "The Bodo and Dhimáls use their wives and daughters well; treating them with confidence and kindness. They are free from all out-door work whatever." Take, again, the Dyaks, who, though not without tribal feuds and their consequences, are yet without stable chieftainships and military organization, are predominantly industrial, and have rights of individual property well developed. Though among the varieties of them the customs differ somewhat, yet the general fact is that the heavy out-door work is mainly done by the men, while the women are generally well treated, and have considerable privileges. With their monogamy goes regular courtship, and the girls choose their mates; St. John says of the Sea Dyaks that "husbands and wives appear to pass their lives very agreeably together;" and Rajah Brooke names Mukah as a part of Borneo where the wives close their doors, and will not receive their husbands unless they procure fish. Then, as a marked case of a simple community having relatively high industrial organization, with elective head, representative council, and the other concomitants of the type, and who are described as "industrious, honest, and peace-loving," we have the Pueblos, who, with that monogamy which characterizes their family relations, also show us a remarkably high *status* of women. For among them not simply is there courtship, and choice exercised by girls; not simply do we read that "no girl is forced to marry against her will, however eligible her parents may consider the match;" but sometimes, according to Bancroft, "the usual order of courtship is reversed; when a girl is disposed to marry she does not wait for a young man to propose to her, but selects one to her own liking and consults her father, who visits the parents of the youth and acquaints them with his daughter's wishes."

On turning from simple societies to compound societies, we find two adjacent ones in Polynesia exhibiting a strong contrast between their social types as militant and industrial, and an equally strong contrast between the positions they respectively give to women: I refer to Feejeeans and Samoans. The Feejeeans show us the militant structure, actions, and sentiments, in extreme forms. Under an un-

mitigated despotism there are fixed ranks, obedience the most profound, marks of subordination amounting to worship; there is an organized military system with its grades of officers; the lower classes exist only to supply necessaries to the warrior-classes, whose sole business is war, merciless in its character and accompanied by cannibalism. And here, along with prevalent polygyny, carried among the chiefs to the extent of from ten to a hundred wives, we find the position of women such that, not only are they, as among the lowest savages, "little better than beasts of burden," and not only may they be sold at pleasure, but a man may kill and eat his wife if he pleases. Contrariwise, in Samoa the type of the regulating system has become in a considerable degree industrial. There is representative government, and chieftains, exercising authority under considerable restraint, are partly elective; while the industrial organization is so far developed that there are journeymen and apprentices, there is payment for labor, and there are even strikes, with a rudimentary trades-unionism. And here, beyond that improvement of women's *status* implied by limitation of their labors to the lighter kinds while men take the heavier, there is the improvement implied by the fact that "the husband has to provide a dowry, as well as the wife, and the dowry of each must be pretty nearly of equal value," and by the fact that a couple who have lived together for years make, at separation, a fair division of the property. Of other compound societies fit for comparison, I may name two in America, North and South, the Iroquois and the Araucanians. Though these, alike in degree of composition, were both formed by combination in war against civilized invaders, yet, in their social structures, they differed in the respect that the Araucanians became decidedly militant in their regulative organization, while the Iroquois did not give their regulative organization the militant form; for the governing agencies, general and local, were in the one personal and hereditary and in the other representative. Now, though these two peoples were much upon a par in the division of labor between the sexes—the men limiting themselves to war, the chase, and fishing, leaving to the women the labors of the field and the house—yet along with the freer political type of the Iroquois there went a freer domestic type; as shown by the facts that the women had separate proprietary rights, that they took with them the children in cases of separation, and that marriages were arranged by the mothers. No definite evidence either way is furnished by the doubly-compound societies of ancient America. The political organization of Mexico was in a high degree militant in type; but along with it there went an elaborate industrial organization, with extensive division of labor and considerable commercial intercourse; and, excepting in the polygyny and concubinage of the upper classes, and occasional inheritance of wives as property, the position of women appears to have been not bad. The Peruvian

nation, which, though less sanguinary in its observances, had the militant structure carried out far more completely, so that its industrial organization formed part of the political organization, gave a lower *status* to women, who did the hard work, and who, in the upper ranks at least, had to sacrifice themselves on the deaths of their husbands.

The highest societies, ancient and modern, are many of them rendered in one way or other unfit for comparisons. In some cases the evidence is inadequate; in some cases we know not what the antecedents have been; in some cases the facts have been confused by agglomeration of different societies; and in all cases the coöperating influences have increased in number. Concerning the most ancient ones, of which we know least, we can do no more than say that the traits presented by them are not inconsistent with the view here set forth. The Accadians, who before reaching that height of civilization at which phonetic writing was achieved, must have existed in a settled populous state for a vast period, must have therefore had for a vast period a considerable industrial organization; and it seems not improbable that during such period, being powerful in comparison with wandering tribes around, their social life, little perturbed by enemies, was substantially peaceful. Hence there is no incongruity in the fact that they are shown by their records to have given their women a relatively high *status:* wives owned property, and the honoring of mothers was especially enjoined by their laws. Of the Egyptians something similar may be said. Their earliest wall-paintings show us a people far advanced in arts, industry, observances, mode of life. The implication is irresistible that, before the stage thus depicted, there must have been a long era of rising civilization; and since this era was passed in an isolated fertile tract, mostly surrounded by such nomadic hordes only as the deserts could support, the Egyptians were relatively strong, and may not improbably have long led a life largely industrial. So that, though the militant type of social structure evolved during the time of their consolidation, and made sacred by their form of religion, continued, yet industrialism must have become an important factor, influencing greatly their social arrangements, and diffusing its appropriate sentiments and ideas. And the position of woman was relatively good. Though polygyny existed, it was unusual; matrimonial regulations were strict, and divorce difficult; "married couples lived in full community;" women shared in social gatherings as they do in our own societies; in sundry respects they had precedence given to them; and, in the words of Ebers, "many other facts might be added to prove the high state of married life."

Ancient Aryan societies illustrate well the relationship between the domestic *régime* and the political *régime.* The despotism of an irresponsible head, which characterizes the militant type of structure, characterized alike the original patriarchal family, the cluster of fami-

lies having a common ancestor, and the united clusters of families forming the early Aryan community. As Mommsen describes him, the early Roman ruler, once in office, stood toward citizens in the same relation that the father of the family did to wife, children, and slaves: "The regal power had not, and could not have, any external checks imposed upon it by law: the master of the community had no judge of his acts within the community, any more than the house-father had a judge within his household. Death alone terminated his power." From this first stage, in which the political head was absolute, and absoluteness of the domestic head went to the extent of life and death power over his wife, the advance toward a higher *status* of women was doubtless, as Sir Henry Maine contends, largely caused by that disintegration of the family which went along with the progressing union of smaller societies into larger ones effected by conquest. But though successful militancy thus furthered female emancipation, it did so only by thereafter reducing the relative amount of militancy; and the emancipation was really associated with an average increase of industrial structures and activities. As before pointed out, militancy is to be measured not so much by success in war as by the extent to which it occupies the male population. Where all men are warriors, and the work is done entirely by women, militancy is the greatest. The introduction of a class of males who, joining in productive labor, lay the basis for an industrial organization, qualifies the militancy. And as the industrial class, at first consisting though it does wholly of slaves, increases in proportion to the militant class, the total activities of the society must be regarded as more industrial and less militant. In another way the same truth is implied, if we consider that when a number of small hostile societies are consolidated by triumph of the stronger, the amount of fighting throughout the area occupied becomes less, although the conflicts now from time to time arising with neighboring larger aggregates may be on a greater scale. This is clearly seen on comparing the ratio of fighting-men to population among the early Romans with the ratio between the armies of the empire and the number of people included in the empire. And there is the further fact that the holding together of these compound and doubly-compound societies eventually formed by conquest, and the efficient coöperation of their parts for military purposes, itself implies an increased development of the industrial organization. Great armies carrying on operations at the periphery of a great territory, imply a numerous working population, a considerable division of labor, and good appliances for transferring supplies: the sustaining and distributing systems must be well developed before large militant structures can be worked. So that this disintegration of the patriarchal family, and consequent emancipation of women, which went along with growth of the Roman Empire, really had for its concomitant a development of the industrial organization.

In other ways a like relation of cause and effect is shown us during the progress of European societies since Roman times.

Respecting the *status* of women in mediæval Europe, Sir Henry Maine says:

> "There can be no serious question that, in its ultimate result, the disruption of the Roman Empire was very unfavorable to the personal and proprietary liberty of women. I purposely say 'in its ultimate result,' in order to avoid a learned controversy as to their position under purely Teutonic custom."

Now, leaving open the question whether this conclusion applies beyond those parts of Europe in which institutions of Roman origin were least affected by those of Germanic origin, we may, I think, on contrasting the condition of things before the fall of the empire and the condition after, infer a connection between this decline in the *status* of women and a return to greater militancy. For while Roman power held together the populations of large areas, there existed throughout them a state of comparative internal peace; whereas its failure to maintain subordination was followed by universal warfare: producing from time to time larger aggregates and again dissolutions of them, until the disintegration had reached the stage in which there existed numerous feudal governments mutually hostile. And then, after that decline in the position of women which accompanied this retrograde increase of militancy, the subsequent improvement in their position went along with aggregation of smaller feudal governments into larger ones, which had the result that within the consolidated territories the amount of diffused fighting decreased.

Comparisons between the chief civilized nations as now existing, yield verifications. Note, first, the fact, significant of the relation between political despotism and domestic despotism, that, according to Legouvé, Napoleon I. said to the Council of State, "Un mari doit avoir un empire absolu sur les actions de sa femme;" and that sundry provisions of the Code, as interpreted by Pothier, carry out this dictum. Further, note that, according to De Ségur, the position of women in France declined under the empire; and that "it was not only in the higher ranks that this nullity of women existed. . . . The habit of fighting filled men with a kind of contempt and asperity which made them often forget even the regard which they owed to weakness." Passing over less essential contrasts now presented by the leading European peoples, and considering chiefly the *status* as displayed in the daily lives of the poorer rather than the richer, it is manifest that the mass of women have harder lots where militant organization and activity predominate, than they have where there is a predominance of industrial organization and activity. The sequence observed by travelers in Africa, that in proportion as the men are occupied in war more labor falls on the women, is a sequence which both France and Germany show us. Social sustentation has to be

carried on; and necessarily the more males are drafted off for military service, the more females must be called on to fill their places as workers. Hence the extent to which in Germany women are occupied in rough, out-of-door tasks—digging, wheeling, carrying burdens; hence the extent to which in France heavy field-operations are shared in by women. That the English housewife is less a drudge than her German sister, that among shopkeepers in England she is not required to take so large a share in the business as she is among shopkeepers in France, and that in England the out-of-door work done by women is both smaller in quantity and lighter in kind, is clear; as it is clear that this difference is associated with a lessened demand on the male population for purposes of offense and defense. And then there may be added the fact of kindred meaning, that in the United States, where till the late war the degree of militancy had been so small, and the industrial type of social structure and action so predominant, women have reached a higher *status* than anywhere else.

Evidence furnished by existing Eastern nations, so far as it can be disentangled, supports this view. China, with its long history of wars causing consolidations, dissolutions, reconsolidations, etc., going back more than 2,000 years B. C., and continuing during Tartar and Mongol conquests to be militant in its activities and arrangements, has, notwithstanding industrial growth, retained the militant type of structure; and absolutism in the state has been accompanied by absolutism in the family, qualified in the one as in the other only by the customs and sentiments which industrialism has fostered: wives are bought; concubinage is common among those adequately well off; widows are sometimes sold as concubines by fathers-in-law; and women join in hard work, sometimes to the extent of being harnessed to the plough; while, nevertheless, this low *status* is practically raised by a public opinion that checks the harsh treatment legally allowable. Similarly Japan, which, passing through long periods of internal conflict ending in integration, acquired an organization completely militant, under which political freedom was unknown, showed a simultaneous absence of freedom in the household—buying of wives, concubinage, divorce at mere will of husband, crucifixion or decapitation for wife's adultery; while, along with the growth of industrialism characterizing the later days of Japan, there went such improvement in the legal *status* of women that the husband was no longer allowed to take the law into his own hands in case of adultery; and now, though women are occasionally seen using the flail, yet mostly the men, according to Sir Rutherford Alcock, "leave their women to the lighter work of the house, and perform themselves the harder out-door labor."

It is, of course, difficult to generalize phenomena into the genesis of which there enter factors so numerous and involved—character of

race, religious beliefs, surviving customs and traditions, degree of culture, etc.; and doubtless the many coöperating causes give rise to incongruities which qualify somewhat the conclusion drawn. But, on summing up the several arguments, we shall, I think, see that conclusion to be substantially true.

The least entangled evidence is that which most distinctly forces this conclusion upon us. Remembering that nearly all simple uncivilized societies, having chronic feuds with their neighbors, are militant in their activities, and that their women are extremely degraded in position, the fact that in the exceptional simple societies which are peaceful and industrial there is an exceptional elevation of women almost alone suffices as proof: neither race, nor creed, nor culture, being in these cases an assignable cause.

The connections which we have seen exist between militancy and polygyny, and between industrialness and monogamy, present the same truth under another aspect; since polygyny necessarily implies a low *status* of women, and monogamy, if it does not necessarily imply a high *status*, is an essential condition to a high *status*.

Further, that approximate equalization of the sexes in numbers which results from diminishing militancy and increasing industrialness, conduces to the elevation of women; since, in proportion as the supply of males available for carrying on social sustentation increases, the labor of social sustentation falls less heavily on the females. And it may be added that the societies in which the surplus of males thus made available undertakes the harder labors, and so, relieving the females from undue physical tax, enables them to produce more and better offspring, will, other things equal, gain in the struggle for existence with societies in which the women are not thus relieved by the men: whence an average tendency to the spread of societies in which the *status* of women is improved.

There is the fact, too, that the despotism distinguishing a community organized for war, is essentially connected with despotism in the household; while, conversely, the freedom which characterizes public life in an industrial community, naturally characterizes also the accompanying private life. In the one case compulsory coöperation prevails in both; in the other case voluntary coöperation prevails in both.

By the moral contrast we are shown another face of the same fact. Habitual antagonism with, and destruction of, foes, sears the sympathies; while daily exchange of products and services among citizens, puts no obstacle to increase of fellow-feeling. And the altruism which grows with peaceful coöperation, ameliorates at once the life without the household and the life within the household.[1]

[1] Too late to be inserted in its proper place, and so late that I have canceled stereotype plates to bring it in, I have met with a striking verification in the just-issued work of Mr. W. Mattieu Williams, F. R. A. S., F. C. S., "Through Norway with Ladies." He says, "There are no people in the world, however refined, among whom the relative posi-

II.

That brutes, however ferocious, treat their offspring tenderly, is a familiar fact; and that tenderness to offspring is shown by the most brutal of mankind, is a fact quite congruous with it. An obvious explanation of this seeming anomaly exists. As we saw that the treatment of women by men cannot pass a certain degree of harshness without causing extinction of the tribe, so, here, we may see that the tribe must disappear unless the love of progeny is strong. Hence we need not be surprised when Mouat tells us that the Andaman-Islanders "show their children the utmost tenderness and affection;" or when we read in Snow's account of the Fuegians that both sexes are much attached to their offspring; or when Sturt describes Australian fathers and mothers as behaving to their little ones with much fondness. Affection intense enough to prompt great self-sacrifice is, indeed, especially requisite under the conditions of savage life, which render the rearing of young difficult; and maintenance of such affection is insured by the dying out of families in which it is deficient.

But this strong parental love is, like the parental love of animals, very irregularly displayed. As among brutes the philoprogenitive instinct is occasionally suppressed by the desire to kill, and even to devour, their young ones, so, among primitive men, this instinct is now and again overridden by impulses temporarily excited. Thus, though attached to their offspring, Australian mothers, when in danger, will sometimes desert them; and, if we may believe Angas, men have been known to bait their hooks with the flesh of boys they have killed. Thus, notwithstanding their marked parental affection, Fuegians sell their children for slaves; thus, among the Chonos Indians, a father, though doting on his boy, will kill him in a fit of anger for an accidental offense. Everywhere among the lower races we meet with like incongruities. Falkner, while describing the paternal feelings of Patagonians as very strong, says they often pawn and sell their wives and little ones to the Spaniards for brandy. Speaking of the children of the Sound Indians, Bancroft says they "sell or gamble them away." According to Simpson, the Pi-Edes "barter their children to the Utes proper, for a few trinkets or bits of clothing." And of the Macusi, Schomburgk writes, "The price of a child is the same as the Indian asks for his dog."

This seemingly-heartless conduct to children often arises from the

tion of man and woman is more favorable to the latter than among the Lapps." After giving evidence from personal observation, he asks the reason, saying: "Is it because the men are not warriors? . . . They have no soldiers, fight no battles, either with outside foreigners, or between the various tribes and families among themselves. . . . In spite of their wretched huts, their dirty faces, their primitive clothing, their ignorance of literature, art, and science, they rank above us in the highest element of true civilization, the moral element; and all the military nations of the world may stand uncovered before them" (pp. 162, 163).

difficulty experienced in rearing them. To it the infanticide so common among the uncivilized and semi-civilized is, of course, mainly due —the burial of living infants with mothers who have died in childbirth; the putting to death one out of twins; the destruction of younger children when there are already several. For these acts there is an excuse like that commonly to be made for killing the sick and old. When, concerning the desertion of aged people by wandering prairie tribes, Catlin says, "It often becomes absolutely necessary in such cases that they should be left, and they uniformly insist upon it, saying, as this old man did, that they are old and of no further use, that they left their fathers in the same manner, that they wish to die, and their children must not mourn for them"—when, of the Nascopies, Heriot tells us that in his old age "the father usually employed as his executioner the son who is most dear to him"—when, in Kane, we read of the Assiniboin chief who "killed his own mother," because, being "old and feeble," she "asked him to take pity on her and end her misery"—there is suggested the conclusion that, as destruction of the ill and infirm may lessen the total amount of suffering to be borne under the conditions of savage life, so may the destruction of infants, when the region is barren or the mode of life so hard that the rearing of many is impracticable. And a like plea may be urged in mitigation of judgment on savages who sell or barter away their children: the needs of the younger ones possibly, in some cases, prompting this sacrifice of the elder.

Generally, then, among uncivilized peoples, as among animals, instincts and impulses are the sole incentives and deterrents. The *status* of a primitive man's child is like that of a bear's cub. There is neither moral obligation nor moral restraint; but there exists the unchecked power to foster, to desert, to destroy, as love or anger moves.

To the yearnings of natural affection are added in early stages of progress certain motives, partly personal, partly social, which help to secure the lives of children; but which, at the same time, initiate differences of *status* between children of different sexes. There is the desire to strengthen the tribe in war; there is the wish to have a future avenger on individual enemies; there is the anxiety to leave behind one who shall perform the funeral rites and continue oblations at the grave.

Inevitably, the urgent need to augment the number of warriors leads to preference for male children. On reading of such a militant race as the Chechemecas, that they "like much their male children, who are brought up by their fathers, but they despise and hate the daughters;" or of the Panches, that, when "a wife bore her first girl-child, they killed the child, and thus they did with all the girls born before a male child," we are shown the effect of this desire for sons; and

everywhere we find it leading either to destruction of daughters, or to low estimation and ill-treatment of them. Through long ascending stages of social life the desire thus arising persists; as instance the statement of Herodotus, that every Persian prided himself on the number of his sons, and it is even said that an annual prize was given by the monarch to the Persian who could show most sons living. Obviously the social motive, thus coming in aid of the parental motive, served to raise the *status* of male children above that of female.

A reason for the care of sons implied in the passage of Ecclesiasticus which says, "He left behind him an avenger against his enemies," is a reason which has weighed with all races in barbarous and semi-civilized states. The sacred duty of blood-revenge, earliest of recognized obligations among men, survives so long as societies remain predominantly warlike; and it generates an anxiety to have a male representative who shall retaliate upon those from whom injuries have been received. This bequest of quarrels to be fought out, traceable down to recent times among so-called Christians, as in the will of Brantôme, has, of course, all along raised the value of sons, and has so put upon the harsh treatment of them a check not put upon the harsh treatment of daughters—whence a further differentiation of *status*.

The development of ancestor-worship, which, enjoining sacrifices to be made by each man at the tombs of his immediate and more remote male progenitors, implies anticipation of like sacrifices to his own ghost by his son, initiates yet another motive for cherishing sons —adds to the parental regard for children a feeling which tells in favor of males rather than of females. The effects of this motive are at the present time shown us by the Chinese, among whom the death of an only son is especially lamented, because there will be no one to make offerings at the grave, and among whom the peremptory need for a son hence arising is held to justify the taking of a concubine, though, "if a person has sons by his wife (for daughters never enter into the account), it is considered derogatory to take a handmaid at all." On recalling Egyptian wall-paintings and papyri, and the like evidence furnished by Assyrian records, showing that sacrifices to ancestors were performed by their male descendant—on remembering, too, that among ancient Aryans, Hindoo, Greek, Roman, the daughter was incapable of this function, and that sons were, therefore, required for maintaining the family-cult—we are shown how this developed form of the primitive religion, while it strengthened filial subordination, added an incentive to parental care—of sons, but not of daughters.

In brief, then, the relations of adults to young among human beings, originally like those among animals, began to assume higher forms under the influence of the several desires—to obtain an aider in fighting enemies, to provide an avenger for injuries received, and to

leave behind one who should administer to welfare after death: motives which, strengthening as societies passed through their early stages, gradually gave a certain authority to the claims of male children, though not to those of females. And thus we again see how intimate is the connection between militancy of the men and degradation of the women.

Here we are introduced to the question, "What relation exists between the *status* of children and the form of social organization?" To this the reply is akin to one given in the last chapter; namely, that mitigation of the treatment of children accompanies transition from the militant type to the industrial type.

Those lowest social states in which offspring are now idolized, now killed, now sold, as the dominant feeling prompts, are everywhere the states in which hostilities with surrounding tribes are chronic. This absolute dependence of progeny on parental will is shown whether the militancy is that of archaic groups, or that of groups higher in structure. In the latter as in the former, there exists that life and death power over children which is the negation of all rights and claims. On comparing children's *status* in the rudest militant tribes with their *status* in militant tribes which are patriarchal and compounded of the patriarchal, all we can say is, that in these last the still-surviving theory becomes qualified in practice; and that qualification of it increases as industrialism grows.

The Feejeeans, intensely despotic in government, and ferocious in war, furnish an instance of extreme abjectness in the position of children. Infanticide, especially of females, reaches nearer two-thirds than one-half; they "destroy their infants from mere whim, expediency, anger, or indolence;" and, according to Erskine, "children have been offered by the people of their own tribe to propitiate a powerful chief," not for slaves but for food. A sanguinary warrior race of Mexico—the Chechemecas—yield another example of excessive parental power: sons "cannot marry without the consent of parents; if a young man violates this law . . . . the penalty is death." By this instance we are reminded of the domestic condition among the ancient Mexicans (largely composed of conquering cannibal Chechemecas), whose social organization was highly militant in type, and of whom Clavigero says, "Their children were bred to stand so much in awe of their parents, that even when grown up and married, they hardly durst speak before them." In ancient Central America family rule was similar; and in ancient Peru it was the law that "sons should obey and serve their fathers until they reached the age of twenty-five."

If we now turn to the few cases of uncivilized and semi-civilized societies that are wholly industrial, or predominantly industrial, we find children, as we found women, occupying much higher positions. Among the peaceful Bodo and Dhimáls, "infanticide is utterly un-

known;" daughters are treated "with confidence and kindness;" and when marriages are being arranged, "there is a consulting the destined bride;" to which add the reciprocal trait that "it is deemed shameful to leave old parents entirely alone." The Dyaks, again, largely industrial, and having an unmilitant social structure, yield the fact stated by Brooke, that "the practice of infanticide is rare," as well as the facts before named under another head, that children have the freedom implied by regular courtship, and that girls choose their mates. We are told of the Samoans, who are more industrial in social structure and habit than neighboring Malayo-Polynesians, that infanticide after birth is unknown, and that children have the degree of independence implied by elopements when they cannot obtain parental assent to their marriage. Similarly with the Negritos inhabiting the island of Tanna, where militancy is slight and there are no pronounced chieftainships: of them we read in Turner that "the Tannese are fond of their children. No infanticide there. They allow them every indulgence, girls as well as boys." Lastly, there is the case of the industrious Pueblos, whose children were unrestrained in marriage, and by whom, as we have seen, daughters were especially privileged.

Thus with a highly-militant type there goes extreme subjection of children, and the *status* of girls is still lower than that of boys; while in proportion as the type becomes non-militant, there is not only more recognition of children's claims, but the recognized claims of boys and girls approach toward equality.

Kindred evidence is supplied by those societies which, passing through the patriarchal forms of domestic and political government, have evolved into large nations. Be the race Turanian, Semitic, or Aryan, it shows us the same connection between political absolutism over subjects and domestic absolutism over children.

In China the destruction of female infants is common; "parents sell their children to be slaves;" in marriage "the parents of the girl always demand for their child a price;" and "forced marriages often produce the most tragic results. . . . A union prompted solely by love would be a monstrous infraction of the duty of filial obedience, and a predilection on the part of a female as heinous a crime as infidelity. . . . Their maxim is, that, as the emperor should have the care of a father for his people, a father should have the power of a sovereign over his family." Meanwhile it is observable that this legally-unlimited paternal power descending from militant times, and persisting along with the militant type of social structure, has come to be qualified in practice by sentiments which the industrial type fosters: infanticide, reprobated by proclamation, is excused only on the plea of poverty, joined with the need for rearing a male child; and public opinion puts checks on the actions of those who purchase children. With that militant type of social structure which, during early wars,

became highly developed among the Japanese, similarly goes great filial subjection. Mitford, qualifying previous statements, admits that needy people "sell their children to be waitresses, singers, or prostitutes;" and Sir Rutherford Alcock says that "parents, too, have undoubtedly in some cases, if not in all, the power to sell their children." It may be added that the subordination of young to old, irrespective of sex, is greater than the subordination of females to males; for abject as is the slavery of wife to husband, yet, after his death, the widow's power "over the son restores the balance and redresses the wrong, by placing woman, as the mother, far above man, as the son, whatever his age or rank." And the like holds among the Chinese.

How among the primitive Semites the father exercised capital jurisdiction, and how along with this there went a lower *status* of girls than of boys, needs no proof. But, as further indicating the parental and filial relation, I may name the fact that children were considered so much the property of the father, that they were seized for his debts (2 Kings iv. 1; Job xxiv. 9); also the fact that selling of daughters was authorized (Exodus xxi. 7); also the fact that injunctions respecting the treatment of children referred exclusively to paternal benefit: as instance the reasons given in Ecclesiasticus, chapter xxx., for chastisement of sons; and the further fact that in Deuteronomy, xxi. 18, stoning to death is the appointed punishment of a rebellious son. Though some qualification of paternal absolutism arose during the later settled stages of the Hebrews, yet along with persistence of the militant type of government there continued extreme filial subordination.

Already in the chapter on the Family, when treating of the Romans as illustrating both the social and domestic organization possessed by the conquering Aryans during their spread into Europe, something has been implied respecting the *status* of children among them. In the words of Mommsen, relatively to the father, "all in the household were destitute of legal rights—the wife and child no less than the bullock or the slave." He might expose his children: the religious prohibition which forbade it "so far as concerned all the sons—deformed births excepted—and at least the first daughter," was without civil sanction. He "had the right and duty of exercising over them judicial powers, and of punishing them as he deemed fit, in life and limb." He might also sell his child. It remains to say that the same implied development of industrialness which we saw went along with improvement in the position of women during the growth of the Roman Empire, went along with improvement in the position of children. I may add that in Greece there were allied manifestations of paternal absolutism: a man could bequeath his daughter, as he could also his wife.

If, again, we compare the early states of existing European peo-

ples, characterized by chronic militancy, with their later states, characterized by a militancy that had become less constant and diffused, while industrialism had grown, differences of like significance meet us.

We have the statement of Cæsar concerning the Celts of Gaul, that fathers "do not permit their children to approach them openly until they have grown to manhood." In the Merovingian period a father could sell his child, as could also a widowed mother—a power which continued down to the ninth century or later. Under the decayed feudal state which preceded the French Revolution domestic subordination, especially among the aristocracy, was still such that Chateaubriand says, "My mother, my sister, and myself, transformed into statues by my father's presence, only recover ourselves after he leaves the room;" and Taine, quoting Beaumarchais and Bretonne, indicates that this rigidity of paternal authority was general. Then, after the Revolution, De Ségur writes, "Among our good forefathers a man of thirty was more in subjection to the head of the family than a child of eighteen is now."

Our own history furnishes kindred evidence. Describing the manners of the fifteenth century, Wright says: "Young ladies, even of great families, were brought up not only strictly, but even tyrannically. . . . The parental authority was indeed carried to an almost extravagant extent." Down to the seventeenth century, "children stood or knelt in trembling silence in the presence of their fathers and mothers, and might not sit without permission." The literature of even the last century, alike by the deferential use of "sir" and "madam" in addressing parents, by the authority parents assumed in arranging marriages for their children, and by the extent to which sons, and still more daughters, recognized the duty of accepting the spouses chosen, shows us a persistence of filial subordination proportionate to the political subordination. And then, since the beginning of this century, along with the immense development of industrialism and the correlative progress toward a freer type of social organization, there has gone a marked increase of juvenile freedom; as shown by a greatly moderated parental dictation, by a mitigation of punishments, and by that decreased formality of domestic intercourse which has accompanied the changing of fathers from masters into friends.

Differences having like meanings are traceable between the more militant and the less militant European societies as now existing. Along with the relatively-developed industrial type of political organization in England, there goes a less coercive treatment of children than in France and Germany, where industrialism has modified the political organizations less. Joined with great fondness for, and much indulgence of, the young, there is in France a closer supervision of them, and the restraints on their actions are both stronger and more numerous: girls at home are never from under maternal control, and

boys at school are subject to military discipline. Add to which that parental oversight of marriageable children still goes so far that little opportunity is afforded for choice by the young people themselves. In Germany, again, there is a stringency of rule in education allied to the political stringency of rule. As writes a German lady long resident in England, and experienced as a teacher: "English children are not tyrannized over—they are *guided* by their parents. The spirit of independence and personal rights is fostered. I can therefore understand the teacher who said he would rather teach twenty German [children] than one English child—I understand him, but I do not sympathize with him. The German child is nearly a slave compared to the English child; it is, therefore, more easily subdued by the one in authority."

Lastly come the facts that in the United States, long characterized by great development of the industrial organization little qualified by the militant, parental government has become extremely lax, and girls and boys are nearly on a par in their positions: the independence reached being such that young ladies often form their own circles of acquaintance and carry on their intimacies without let or hinderance from their fathers and mothers.

As was to be anticipated, we thus find a series of changes in the *status* of children parallel to the series of changes in the *status* of women.

In archaic societies, without law and having customs extending over but some parts of life, there are no limits to the powers of parents; and the passions, daily exercised in conflict with brutes or men, are restrained in the relations to offspring only by the philoprogenitive instinct.

Early the needs for a companion in arms, for an avenger, and presently for a performer of sacrifices, add to the fatherly feeling other motives, personal and social, tending to give something like a *status* to male children; but leaving female children still in the same position as are the young of brutes.

These relations of father to son and daughter, arising in advanced groups of the archaic type, and becoming more settled where pastoral life originates the patriarchal group, continue to characterize societies that remain predominantly militant, whether evolved from the patriarchal group or otherwise: victory and defeat, which express the outcome of militant activity, having for their correlatives despotism and slavery in military organization, in political organization, and in domestic organization.

The *status* of children, in common with that of women, rises in proportion as the compulsory coöperation characterizing militant activities becomes qualified by the voluntary coöperation characterizing industrial activities. We see this on comparing the most militant un-

civilized peoples with others that are less militant; we see it on comparing the early militant states of existing nations with their later more industrial states; we see it on comparing nations that are now relatively militant with those that are now relatively industrial. And we are especially shown it by the fact that in primitive uncultured societies which are exceptionally peaceful the *status* of children is exceptionally high.

Most conclusively, however, is this connection shown on grouping the facts antithetically thus: On the one hand, savage tribes in general, chronically militant, have, in common with the predominantly militant great nations of antiquity, the trait that a father has life and death power over his children. On the other hand, the few uncivilized tribes which are peaceful and industrial have, in common with the most advanced civilized nations, the trait that children's lives are sacred, and that large measures of freedom are accorded to both boys and girls.

IMAGINATION.[1]

By Dr. ELLIOTT COUES, U. S. A.

LADIES AND GENTLEMEN: Amid the asperities of the great political crisis which has convulsed a nation, it is pleasant to find the elegant repose of a *salon* where culture and refinement stand like sleepless sentinels on guard against dissension; and in the Lenten season—when the fugitive madrigal of society is hushed in the measured cadence of the penitential psalm, and the brilliant poppies of fashion grow pale in the shadow of the palm—it is meet that thought should turn from outward things to the contemplation of those within.

The few moments during which an unworthy member of the Society is indulged to-night will be devoted to the consideration of Imagination as one of the intellectual faculties which, if common in some degree to all, is nevertheless, in its highest development, the rarest, most precious, and most splendid, of human endowments. I need not—I shall not—be coldly critical now, nor seek to bend your judgment to my will; for I must speak my aspirations, not my personal experiences, and move you from the heart, or not at all. The subject bids defiance to the trammels of custom or precedent, and will be bound by no conventionality.

For *facts*, as simply such, I dare say I have a great and growing contempt, perhaps less due to any familiarity I may have acquired, than to my habitual contemplation of structures without reference to

[1] Read before the Literary Society of Washington, D. C., March 17, 1877.

the materials of which they are composed. The architect, not his workmen—the plan, not the details of its execution—the design, not the methods of its accomplishment—these are within the higher view to which intellectual insight may aspire. Let us pay tribute to the gifted poet who taught us to contrast the insignificance of a fact with the sublime signification of a truth. No one may imagine for a moment that the imaginative faculty is an imaginary thing, or doubt the reality of imagination, because it is immaterial and immeasurable, inscrutable to the physical senses, unsusceptible of analysis or synthesis, triable by no test, overriding logic, outwitting philosophy, laughing at science—this imperious mistress of mind, this fertile mother of all art!

This, that, and the other, of things unnumbered, material and immaterial, wise and otherwise, make up the marvelous microcosm we call Self—the world where, like the sun of the planetary system, shines the intellect with perfect splendor. But, as the spectrum has dissected the solar ray, so has the understanding, by a process of self-inflicted vivisection that seems scarcely less than divine in its insight, pierced and resolved the mysteries of its own composition. We know that the mind is a bundle of many fagots, the united strength of which can never be broken, though racked on doubt and put to the wheel of despair—though cast beneath the car of superstition, or consigned to the nether millstone of inhuman persecution. We know that these mental fagots are of many kinds—sturdy oak of the scientist, pliable ash of the schoolman, sail-bearing pine of the positivist, cypress of pessimist, rose-wood of optimist, heart-wood, it may be, for all of us; and the one mysterious piece, so like and yet so unlike them all. Let the rest season, nay, even blacken: this one is changeless and ever-enduring, as fresh and as green as if cut but to-day from the parent stem; it buds on forever, like a wonderful air-plant whose tendrils find nourishment wherever there is sensitized atmosphere, and needs the grosser nurture of no vulgar mould; this veritable Hamamelis, witch-hazel of the mental sheaf, fitly styled the "divining-rod;" for this is the magic wand of the sculptor, the painter, the poet, the singer, the seer alike!

Technical definition of the imagination may be found in the dictionaries of all civilized languages—those monuments of learning and labor which compel the most profound respect, while they excite the liveliest emotions of gratitude and sympathy for the men who were born to erect them. But the conventional label of the imaginative faculty need not be recited before this Society; nor need I enlarge upon its manifest inadequacy beyond the requirements of formalism. Definition is, or should be, diagnostic description; but in what terms may that be described which exists only in imagination? Definition implies limitation and boundary; the gist of the term is the setting of corner-stones; but how measure off and survey that which is

boundless? No syllogism is competent here. Let imagination seek its own conclusions, with strong white wings that melt not even in the dazzling light and heat of its own glorious achievements. What care I for the crutch of logic here, or any Ariadne's thread in a labyrinth of verbal niceties! Enthusiasm bears too hard upon the check-rein of sober reflection; fancy leaps lightly; ecstasy beckons, and the lotos is waving over the still, cool waters of my judgment. But expression may lawfully seek even the pinnacle of rhapsody, for naught but superlatives are fitting for that which is beyond comparison.

We can but imagine the possibilities of this attribute of intellect; as its peculiarities deny comparison, and its processes scrutiny, so do its powers defy comprehension. But what of its effective operation and manifest results? What of its purposes and pleasures—of its pangs and penalties? And what, alas! of its perversions? Of these we know something, if not from our own experience, then from the teachings of the consummate masters of expression whose thought-laden voices strike home—or, should they pass over our heads, leave us, at least, in no doubt that something has gone over.

To a practical point first: one excellent and most useful purpose which the imagination subserves at the hands of the gifted few whom the higher development of this faculty makes leaders of thought and watchful guardians of human progress, is, to put men of science on their proper level, and to teach them to know their place.

As this may possibly be considered—by some of my friends whose generous appreciation of my efforts in scientific lines of inquiry may blind them to the slightness of my acquirements—to be rather a ticklish position for me to assume, let me fortify with authority as well recognized in literature as is that of the sinewy, daring, and brilliant gladiator of the scientific arena who stigmatized poetry as "sensuous caterwauling."[1] It has been perceived and said, in sub-

[1] Although, in the sphere of imagination, "facts" are apt to be regarded as troublesome and impertinent, and looseness of statement as only a very venial transgression, yet, for the benefit of those readers who care for accuracy, it may be stated that the author of this celebrated phrase, that has given so much offense to artistic and poetic minds, did not use it in the manner here stated. Prof. Huxley has never, as we are aware, "stigmatized poetry as sensuous caterwauling." It was not poetry itself, but only *some* poetry, to which he applied this eminently felicitous epithet; and if Wordsworth were living, he would no doubt cordially indorse it. We give the memorable passage, as it will bear frequent repeating.—(Ed.)

"In these times the educational tree seems to have its roots in the air, its leaves and flowers in the ground; and I confess I should very much like to turn it upside down, so that its roots might be solidly imbedded among the facts of Nature, and draw thence a sound nutriment for the foliage and fruit of literature and of art. No educational system can have a claim to permanence unless it recognizes the truth that education has two great ends to which everything else must be subordinated. The one of these is, to increase knowledge; the other is, to develop the love of right and the hatred of wrong.

"With wisdom and uprightness a nation can make its way worthily, and Beauty will follow in the footsteps of the two, even if she be not specially invited; while there is, perhaps, no sight in

stance, that the great scientists and the great artists are in really closer brotherhood than many suppose—they hold divided sway over much common ground; it is only a seeming paradox, that few discoveries in science, perhaps no great ones, have been made without the exercise of the imagination, or of some faculty so nearly like it that distinction between them is difficult; for the line which separates the operations and results of imagination from those of induction is obscure. Ratiocination is the twin-brother of imagination. The apple that Eve plucked, and the apple that Newton saw fall, grew on the same tree.

But to my intrenchment: "Poetry," says one who understood it, "is the first and last of all knowledge—it is immortal as the heart of man. If the labors of the men of science should ever create any material revolution, direct or indirect, in our condition, and in the impressions which we habitually receive, the poet will sleep then no more than at present; he will be at the side of the man of science, carrying sensation into the midst of the objects of science itself. The remotest discoveries of the chemist, the botanist, the mineralogist, will be as proper objects of the poet's art as any upon which it can be employed, if the time should ever come when these things shall be familiar to us, and the relations under which they are contemplated by the followers of the respective sciences shall be manifestly and palpably material to us as enjoying and suffering beings. If the time should ever come when what is now called science, thus familiarized to men, shall be ready to put on, as it were, a form of flesh and blood, then the poet will lend his divine spirit to aid the transfiguration, and will welcome the being thus produced as a dear and genuine inmate of the household of men."[1]

This utterance of half a century ago seems like prophecy now when the presaged changes are imminent. The conflict may nevertheless be protracted as long as either contestant is blinded to the real strength of his antagonist—senseless though it be to attempt the impossible divorce of the material from the immaterial, of matter from force, of the body from the spirit—that would be death. And it is the physicist himself who is loudest to proclaim that, without the force which gives motion to material particles, there is no light, no heat, no life.

the whole world more saddening and more revolting than is offered by men sunk in ignorance of everything but what other men have written—seemingly devoid of moral belief or guidance, but with the sense of beauty so keen, and the power of expression so cultivated, that their sensuous caterwauling may be almost mistaken for the music of the spheres.

"At present, education is almost entirely devoted to the cultivation of the power of expression and of the sense of literary beauty. The matter of having anything to say beyond a hash of other people's opinions, or of possessing any criterion of beauty, so that we may distinguish between the godlike and the devilish, is left aside as of no moment. I think I do not err in saying that, if science were made the foundation of education, instead of being, at most, stuck on as a cornice to the edifice, this state of things could not exist."

[1] Quoted from E. C. Stedman's "Victorian Poets," the page where Wordsworth is thus reproduced being further laid under contribution.

Here I would repeat with emphasis, what I intimated in the beginning, that the microscopic eye which peers too long and too intently upon the motes of facts which play in the sunbeam, will be blinded to the force and beauty of the truths which both the motes and the beam conspire to announce.

In thus insisting upon the intimate relationships which I believe subsist between the offices of the imaginative and those of the reasoning faculty, I must not be misunderstood to depreciate or disparage the mighty prowess of the latter, which I love to contemplate. Pure reason, as expressed—I had nearly said symbolized—in the simple, faultless syllogism, has nothing to fear from the sovereignty of the imagination. It is beautiful and fearful to see that clear, cold, naked blade, gleaming with steel-blue temper, resistlessly incisive—to see it cleave with equal ease the solid ingot of ignorance and the gossamer web of illusion—to see it work like a giant steam-hammer, smoothly, noiselessly, and irresistibly, whether its power be adjusted to the cracking of an egg-shell of superfine subtilties, or the forging of the massive links by which it is anchored secure in a storm of error. Yet this Titan is not omnipotent; its powers are limited; and it is precisely at the point where reason hesitates that the office of imagination begins. The higher faculty takes up the story when reason omits to point the moral, and adorns the tale that Nature tells to man. It brings her seeming discords into one grand harmony, and crowns the noble shaft of Science with the immortal wreath of Art.

I speak of imagination in its full development, and in the truest, highest, and best sense that the term can bear; and I am reminded here to draw a broad, even if a devious and uncertain, line of distinction between this splendid faculty and mere Fancy—a pert Miss, whose wills-o'-the-wisp are too often mistaken for the head-light of the imagination. I will not weary you with over-nice formalities of definition in a case where shades of difference blend. Know, by their fruits, that fancy is a parody on imagination. The play of fancy is quips and quirks and airy nothings, and the whole mob of littlenesses we call smart and clever. The working of imagination breathes life into marble and canvas, inspires the drama, the poem, the symphony, and vivifies systems of religion.

What faculty but the imaginative can conceive, what but the power of the imagination itself can convey, the full meaning of this soul of genius? It is creative; and, when this is said, expression falters by the wayside of anticlimax. If there be within us one single spark of the divine fire, this spark it is that sends "the long light shaking" from pillar to pillar of the temple that the lesser god of the imagination rears to a God eternal, till it irradiates the shrine where all men sooner or later must kneel in devotion; and we, who now gaze wistfully at the veil which screens the inner sanctuary from eyes

profane, may yet be permitted to kiss the hem of a seamless garment. Oh, the searching, the far-reaching insight of the epigram, "If there be no God, man must invent one!" Invention, conception, imagination, creation, are synonymous, and in one sense convertible terms.[1]

The pleasures of the imagination—if so slight an expression may hint at a meaning, the fullness of which is rapture or transport—are manifold, and too manifest to require subtilty of discrimination for their recognition and explanation. These are among the things of blessed memory, of blissful hope, and among those the reality and universality of which are confirmed by all experience. Even those who cuddle the bantlings of their fancy, in the fond delusion that they nurture the offspring of the fertile mother, feel somewhat of the charm indescribable. What, then, the serenity, what the majestic repose, of the creators of thought after their labor, we may only faintly imagine.

What of the pangs and penalties now—what of the price to be paid for this power? To bring forth in travail was not the sentence of one-half the human race alone. There have been those, indeed, like Raphael, who have wrought the miracles of imagination in the sunshine of the heart, to sweet music of the soul; but oh, so few escape the throes of thought-birth! Physiologists tell us of a certain mental process they call "unconscious cerebration." The operation of the imagination unconscious of labor is better known by another name—inspiration; its expression is revelation; its mouth-piece the seer. But rare clay, and only the finest, incases such spirits; men must work in the storm, in sorrow and suffering, each to his measure of creative ability. Let us never forget, in the terrible struggle for expression, that it is given to lips which press the sword of pain to speak to fellow-men the words "Go thou up higher!"

I crave your indulgence for one other thought. Authority and responsibility go hand-in-hand with equal pace. The measure of creative ability is the measure of accountability for its exercise, and the measure of the penalty which perversion of the godlike faculty entails. Like every other energy in Nature, the imagination is equally potent for good and for evil. Let the bravest man tell me he never shudders when he looks within, at the possibilities there disclosed. There is power to make this earth seem nearer heaven or hell. Whose rebellious imagination conceived it were better to reign below than to serve above? Sound is as full of discord as of harmony. Light may blind us, or guide us on our way. Heat constructs and heat destroys. The dual nature of every force wars with its opposite. The imagination is equally potent to sanctify and to pollute. Guard, then, this gift with fear and trembling; great issues depend upon this most powerful, most perilous, and most precious endowment of the intellect. Not like the victor in history need we sigh for other

[1] "In seinen Göttern malet sich der Mensch."—GOETHE.

worlds to conquer, if we move the world of the imagination to the ends of truth and beauty; for a greater triumph is ours then, and the soul may leap at the inward shout, "Victory! victory! conquest of self!"

A PHILOSOPHICAL EMPEROR.[1]

By CALVERT VAUX.

AT our last meeting we listened with keen interest to all Mr. Lewis had to say about the Emperor Justinian; and his dramatic presentation of the subject cannot fail to leave a permanent impression on our minds, in regard to the life of this conspicuous example of a bad type of Roman. Selfish and sensuous, remorseless, bloodthirsty, energetic, full of vitality, a barbarian at heart; repulsive in his theories, odious in his practices, true to the woman he chose with an accurate instinct as his mate—not as wife or mother, or with any respect for the sex to which she belonged, but rather as an exaggerated exception to every idea that was then, and is now, current in regard to what a woman ought to be. There was nothing attractive or genial in the life of either Justinian or Theodora; and, so far as this forcible sketch allowed us to form an opinion, we were unable to discover any suggestion in the so-called civilization of the period that would be likely to help us in these times.

Imperial Rome, at the beginning of the Christian era, may of course be viewed from a different standpoint; and it seems to me worth while to-night to follow the clew that is given us by the writings of another Roman emperor, Marcus Antoninus, who began his reign in the middle of the second century.

We do not depend here on any exaggerated history, or on a narrative full of misstatements, of the biased and interested kind, that appertain to the work of a contemporary reporter; but we have the clean words of the man himself, "published, and not published," as Aristotle said of his own writings to Alexander, who expressed a distaste to having such exquisitely subtile brain-work scattered broadcast in the common highway, where it might be picked up by anybody. The volume seems to be a commonplace book, made up of notes that have no special connection with each other in the pages on which they happen to stand, but are very definitely related in the sequence of moods that occur to the writer. It would, indeed, be interesting to collate the scattered beads of similar color, and group them together.

[1] "Marcus Aurelius Antoninus," a paper read before the New York "Fraternity Club."

When the Japanese embassadors visited the United States, it was remarked that the manners of the most refined men among them were essentially European or American, if we choose so to state it; not that they were in the smallest particular borrowed or assumed, but because there is a logic in the culture of the human being, that brings about the same results all the world over, so far as manners are concerned. The style of Marcus Antoninus has this cosmopolitan air. He seems to have been the really complete ideal of a cultivated man; and his ways of thinking, his methods of expression, his social views, his manners, in fact, are correspondingly broad.

He would be at home in any century; but in none so completely, it seems to me, as in the nineteenth. You long to hear of his introduction to Darwin and Spencer, and feel that the conversation would grow interesting at once. The deeply-rooted doctrine of special creation is, we know, now losing force day by day, for all who have the opportunity to become acquainted with the current results of scientific investigation, even in a superficial, popular way. The invention of a matured animal is seen to be inconceivable, because all the facts that appertain to the idea of maturity are so definitely associated with the recognition of advancing age, that the conceptions are found to be inseparable. One of the scientific puzzles has therefore been to account in an intelligent manner for the different phases of life that occur from age to age; to suggest, as it were, some positive vehicle whose duty it has been to carry along the sequence of influences from generation to generation. Draper makes a suggestion in this direction, and points out that *the air we breathe* is the grand receptacle from which all living things come, and to which they all return. It is, he says, the cradle of vegetable, the coffin of animal life: made up of atoms that have once lived, and that have run through innumerable cycles of change, its particles await their turn for further reorganization. A corresponding thought also appears to have passed through the mind of Antoninus; not, of course, precisely in the same form, but there is an intelligible hint of the idea in the following sentence: "If souls continue to exist, how does the air contain them from eternity?"

Every era has what may be called its fashionable real problem for discussion. Sometimes it is ethical; at others, mechanical; or it may be artistic.

The recognition of a process of development in all things—or, as it is well termed, "evolution"—is the essential natural law which seems just now to be the important centre of scientific interest; and it may almost be said to be an outgrowth of the present decade. Yet in our author we see the same kind of yeast fermenting, and becoming an incisive statement in appropriate words. "Observe constantly that all things take place by change. Accustom yourself to consider that the nature of the universe loves nothing so much as to change

the things which are, and to make new things like them. . . . For everything that exists is, in a manner, the seed of that which will be, and to think only of seeds that are cast into the earth, or into a womb, is a very vulgar notion. . . . In the series of things, those which follow are always aptly fitted to those which have gone before; and the things which come into existence exhibit no mere succession, but a certain wonderful relationship. . . . You exist as a part; you will disappear in that which produced you; or, rather, you will be received back into its seminal principle by transmutation. And, by consequence of such a change, I too exist, and those who begat me, and so on forever in the direction of the past; for nothing hinders us from saying so, even if the universe is administered according to definite periods of revolution."

Although habitually thoughtful and theoretical, his main desire is to be equal to the work of the day, whatever it may be. He expects to meet with opposition, as a matter of course, and tries to be always light-armed, cheerful, and ready for a run to the nearest summit, from which a new view may be obtained.

His experience shows the immense advantage of good fortune, when crystallized in the form of a liberal, far-reaching education; and one feels that to produce a man so cool, complete, and many-sided, none of his advantages were less than he required. The instinct that suggests the possession of wealth as a desideratum to nine-tenths of the race, finds here a sufficient defense. We want to have leisure, opportunity, plenty of right to occupy other people's time, and plenty of time to exercise our rights. In Antoninus we find a man, an emperor, who has been liberally brought up from the first; who confesses to having always had everything good under the sun; who complains of nothing in his personal experience; and who is as far as possible from repeating the words of his Oriental predecessor, "Vanity of vanities, all is vanity." Nothing of the kind appears in his notes. He is a shrewd, busy, responsible man of the world; always giving orders and attending to the details of his position. He is, of course, never free from the influence of flatterers, hypocrites, and time-servers. He is exposed to selfish, baneful influences, as every emperor must be, but he is equal to the emergency; his self-respect encourages him constantly to draw the line between his own and other people's experiences, and to keep his own unconfused. He is temperate and simple in his personal habits from taste and from principle.

When the Russian Emperor Nicholas, who was a military chief in the fullest sense, visited England, he took his iron camp-bedstead into every palace that was placed at his service. The Duke of Wellington had the same habit to his dying day, his bedroom being a bare and almost unfurnished apartment. Antoninus had this soldier's custom, but "he loved temperance for its elegance, not for its austerity." It is possible, he says, for a man to live in a palace without

wanting either guards or embroidered dresses, or torches and statues, and such-like show. It is, in fact, in such a man's power to bring himself *very nearly* to the fashion of a private person, without being for this reason either meaner in thought or more remiss in action with respect to the things which must be done for the public interest in a manner that befits a ruler. He doubtless received a forcible influence in this direction from his uncle, the emperor who preceded him, in regard to whom he says: "The things which conduce in any way to the commodity of life, and of which fortune gives an abundant supply, he used without annoyance, so that when he had them he enjoyed them without affectation, and, when he had them not, he did not want them."

He appears to have been himself at an early age a hard student, to have adopted a plain, coarse dress, and to have lived a laborious, abstemious life. He was of a winning nature, and had a great affection for his teachers, who were numerous, and all eminent in their several professions. His uncle and adoptive father, Antoninus Pius, a truly noble man, gave by his example the key-note to many points in the character and taste of Marcus. He studied law carefully to fit himself for the high place he was destined to fill, and of course learned the Roman discipline of arms. He abandoned the studies of poetry and rhetoric advisedly; not from any lack of appreciation, but partly because he was made aware that his gift did not lie in that direction, and partly because he found these studies too fascinating for a young man with the responsibilities before him that he expected to assume.

Although he began his reign a century and a half after the birth of Jesus, it is evident that he is unaware of any influence that has been brought to bear on his own mind that may be traced to this source. "A soul," he says, "should be ready at any moment to be separated from the body, to be extinguished, or to continue to exist; but this readiness should come from a man's own judgment, not from mere obstinacy, as with the Christians."

There is, according to Leslie, sufficient evidence that he did not prevent, as he might have done by direct edict, a persecution of Attalus and other Gallic Christians in the year 177. In his time the opposition between the old and the new belief was continually growing stronger, and the adherents of the heathen religion urged those in authority to a more regular resistance to the invasions of the Christian faith. It must of course be remembered that the Christians themselves maintained that all heathen religions were false, and openly opposed the heathen rites; thus making a declaration of hostility against the Roman Government, which tolerated all the various forms of superstitious worship that existed in the empire, and that could not consistently leave unrebuked an intolerant religion, which declared that all the rest were false. The rules against the Christians were

made in the time of his predecessor, Trajan; and his own powers were, doubtless, limited by constitutional forms.

Among his acknowledgments to his teachers and friends, he mentions that he learned from his governor to be neither of the green nor the blue party at the games in the circus (showing that the feud was in active force at the time); also endurance of labor, to want little, to work with his own hands, not to meddle with other people's affairs, and not to be ready to listen to slander. "From Rusticus," he says, "I learned not to be led away to sophistic emulation, nor to be writing on speculative matters, nor to deliver little hortatory orations, nor to be showing myself off as a man who practises much discipline." From the same teacher he also learned not to walk about the house in his out-door dress, and, as he says, "to write my letters with simplicity, like the letter Rusticus himself wrote from Sinuessa to my mother."

He appears to have been a Stoic, and thanks one of his tutors for introducing him to Epictetus; but he had none of the harshness, indifference, or self-assertion, that has become associated with the idea of Stoicism—perhaps a little unjustly, although there is always some ground for a good, wholesome prejudice against such a representative word.

For his wife, Faustina, he expresses great admiration. Neither she, however, nor her mother, who had the same name, succeeded in preserving a character unspotted from attack by the historians; and if his wife deserves the criticisms that are extant (of second-rate authority, however, Leslie says), even the Theodora that Prof. Lewis has given us so vivid an account of was hardly more vicious in taste, or reckless in practice. Swinburne has chosen her name as the key-note for a *tour de force*, and makes it the lay-figure on which to drape forty verses, in each of which the second line rhymes with Faustine. She seems in the poem to be closely related to Poe's Leonore, who was eliminated (the author tells us) out of his personal consciousness in accordance with the logical rules of imaginative and rhythmic art.

> "You have the face that suits a woman for her soul's screen,
> The sort of beauty that's called human in hell, Faustine.
> You could do all things but be good or chaste of mien,
> And that you would not if you could. We know Faustine."

His individual view of domestic life must, however, count for much, even in opposition to Swinburne. He says: "I thank the gods that, though it was my mother's fate to die young, she spent the last years of her life with me; that I have such a wife, so obedient, so affectionate, and so simple; and that I had abundance of good nurture for my children."

It is, perhaps, fair enough for the teacher to say that faith is best

shown by works; but the interesting aspect of any faith is best shown by the theory involved, the intellectual ideal, the point aimed at, the sweep of the curve; and we are at no loss for information of this kind with regard to Antoninus, although there is but little record of his personal practice. His faith, as a man of the world, was in a good, social habit of life; in active, industrious, kindly coöperation. He believed in the present opportunity, in its duties especially. Enjoy life (he says) by joining one good thing to another, so as not to leave even the smallest interval between; and make your acts refer to nothing else than to a social end—not forgetting that the kinship is close between every man and the whole human race, which is not a community of a little blood or seed, but of intelligence.

Although an emperor, he was, therefore, in a certain sense, a very good republican; and he argues that we ought to propose to ourselves an object in life that shall be of a socially political kind, and actually stigmatizes any thought that tends to destroy social union as one of four principal aberrations of the superior faculty. He has an appreciative sense of humor that would easily become grim, if the whole soul of the man were not basked in sunshine, and full of good-tempered acquiescence in the mysterious chances (as they seem to be) of Providence. Heraclitus, he says (after so many speculations on the conflagrations of the universe), was filled with water internally, and died smeared over with mud.

He then gives several other equally untoward illustrations, and proceeds quite cheerfully to draw his moral and urge a constant readiness to close the voyage of life.

The defect in his range of ideas is in the direction that might be anticipated—in the too great detachment and isolation of the purely mental capacity. We do not find a comprehension of the close and intimate connection between material and immaterial (amounting to identity so far as personal experience is concerned), which has been established by modern scientific research. An undue prominence is given to the power of individual will in the direction of self-control and the avoidance of evil; sufficient allowance is not made for human nature—that is, the exaggerations of passion, appetite, or, in general terms, of temperament. There is, however, no suggestion of prejudice, no shallow closing of the avenues through which fresh information may come, and one feels that when with our modern opportunities for investigation it does come, the fresh statement is in harmony with what has preceded it in the definitions of Antoninus, which prove to be right as far as they go, but are incomplete.

Although a logician on principle, by natural gifts, and by constant practice, there is nothing pitiless in his logic. It would almost seem that he had been aware of the hardness that so easily accompanies the power to state with precision a sequence of cause and effect, and he chooses rather to show how easy it is to prove logically that

a charitable view may be taken of the evil doings of others. He says, for example: "When a man has presented the appearance of having done wrong, say, how can I be certain that this is a wrongful act? And even if he has done wrong, how do I know that he has not condemned himself?"

His definition of the way in which injuries should be met shows the true Christian spirit. He urges as invincible the continuance of a benevolent disposition toward even the most violent, and recommends that you "quietly admonish him and calmly correct his errors at the very time when he is trying to do you harm; saying, 'Not so, my child, we are constituted by Nature for something else;' and show him his error, with gentle tact, not with any double meaning or in the way of reproach, but affectionately and without any rancor in your soul, not as if you were lecturing him, nor yet that any by-stander may admire, but either when he is alone, or with caution as if he were alone."

His style is not particularly elegant, certainly not poetic or imaginative, but it has an intensely masculine quality, and its virile power of grasp is sufficient to insure to the thoughts of Marcus Antoninus a long future.

When an ethical principle is to be inculcated about which (we will assume) there is no difference of opinion, the appeal will be made to one kind of intelligence by thinkers of the calibre of (let us say) George Herbert, and to another kind by studious inquirers of a type which may be represented by Emerson and Antoninus, about whom all that one can say in the way of definition is that his appeal in each separate instance seems to be directly made without qualification or limitation, to himself, to you, to me, to every being capable of understanding the meaning of ordinary words. It is never special, but always general and in the direction of character which belongs, like the air, to every human being, and not in the direction of genius or acquirement, which is owned like the earth by human beings very unequally. Take, for instance, the following quotations: "You say, men cannot admire the sharpness of your wit. Be it so. But there are many other things of which you can hardly say you are not formed for them by Nature. Show those qualities then which are altogether in your power, sincerity, gravity, endurance of labor, contentment with your portion, benevolence, frankness, freedom from trifling, magnanimity. Do you not see how many qualities you are immediately able to exhibit in which there is no excuse for natural incapacity and unfitness?"

The most potent charm of the Christian doctrine is in this direction. It is adapted to the rich and poor, but chiefly to the poor; to the educated and uneducated, but very decidedly to the uneducated. Probably the philosophy of Antoninus, emanating, as it does, from a rich, unhampered experience, bears the marks of the habitual sur-

roundings, and is more polished and metaphysical than it would have been if its author had been born in a hut; but it is nevertheless always practical, and while clearly recognizing that there are inevitable limitations of human power, it makes a grand claim for the possible capacity of human intelligence; it is not a system of in-door ethics that fails of efficiency when taken into the open air and exposed to the weather. Take, for example, what he says of religion: "To those who ask, 'Where have you seen the gods? how do you comprehend that they exist? why do you worship them?' I reply, in the first place, that they *may* be seen even with the eyes. In the second place, I have not seen my own soul, yet I honor it; and in respect to the gods, from what I constantly experience of their power, I comprehend that they exist, and I venerate them."

Of immortality he says: "It hardly seems possible that men who through pious acts have been most intimate with the Divinity, when they die should be completely extinguished. But if this is so, rest assured that it ought not to have been otherwise; for, you see, in this inquiry you are disputing with the Deity, who would not have allowed anything in the order of the universe to be neglected unjustly and irrationally. . . .

"Wait for death with a cheerful mind, as being nothing else than a dissolution of the elements of which every human being is compounded. But if there is no harm to the elements themselves in each continually changing into another, why should a man have any apprehension about the change and dissolution of all the elements; for it is according to Nature, and nothing is evil that is according to Nature." It may, of course, be claimed that he is an altogether exceptional man, and that his lofty views were unshared by his contemporaries. This, however, is not a sufficient explanation.

In a note to one of Moore's songs we are told that it was founded on this anecdote in Warren's "History of Ireland:" "The people were inspired with such a spirit of honor, virtue, and religion, by the great example of Brien, and by his excellent administration, that as a proof of it we are informed that a young lady of great beauty, adorned with jewels and a costly dress, undertook a journey alone from one end of the kingdom to the other, with a wand only in her hand, on the top of which was a ring of great value; and such an impression had the laws and government of this monarch made on the minds of all the people that no attempt was made upon her honor, nor was she robbed of her clothes and jewels." Whether this history is true or not, there is no gainsaying the fact that it existed in the popular Irish thought, or it would never have found expression. It requires a delicate and chaste imagination to conceive of such a legend, and the character of the people to-day seems to justify us in admitting its essential probability.

These writings of Antoninus may be accepted in a similar sense as

proof positive in regard to the good type of an imperial Roman. The ideas could not have grown in an isolated way on uncongenial soil; there must have been other good, imperial Romans, and many of them. He is a noble exemplar of his own age, and we learn through him to respect his contemporaries. He is also interesting as a representative man in a more extended sense. He combines the cool, unbiased, intrepid spirit of modern scientific inquiry with the earnest veneration of the moralist, and the speculative curiosity and audacity of the metaphysician. To-day we find the scholars and poets a little out of sympathy with the scientific men, and the men of science declaring war against such doctors of orthodoxy as persist in standing aloof on (what they think) intrenched ground.

Antoninus seems to be habitually clear from prejudice or superstition. When he makes a statement it is evident that he is giving us his views as fully and freely as possible, without let or hinderance, and this absence of partisanship constitutes the special charm that seems destined to give a fresh perennial interest to his monograph. The subjects he touches on are of universal value to all human beings when in a thoughtful mood, and it seems very doubtful whether his pure and forcible statements will ever lose their power, because they have been from the outset so thoroughly refined from all dross in the literary method of their presentation that it is hardly possible to conceive of any advance in culture that will leave them behind the age in this respect.

BAD ODORS IN RESERVOIRED DRINKING-WATER.[1]

From Professor S. A. LATTIMORE'S Report.

THE citizens of Rochester were much inclined to congratulate themselves—and certainly on excellent grounds—when they had brought water thirty miles from the crystal depths of Hemlock Lake for the use of the city. But last year, to the astonishment and disgust of the people, their water became so offensive as to give rise to grave apprehensions respecting its effect on public health. In October it suddenly began to emit a peculiar fish-like odor, which continued until the following December. It was a very natural suggestion that this odor must be due to the presence of fish, which had somehow found their way from the lake into the main pipes, and thence into the smaller service-pipes, where their progress had been arrested, and they were undergoing slow decomposition. It is well known to those familiar with the experience of other large cities, that

[1] Abstract of a Report to the Executive Board of the City of Rochester, N. Y., on the Recent Peculiar Condition of the Hemlock Lake Water-Supply. By S. A. Lattimore, Ph. D., LL. D., Professor of Chemistry in the University of Rochester.

similar annoyances are by no means uncommon elsewhere. Regarding this we learn that "not long after the introduction of the Croton water into New York, and of the Cochituate water into Boston, the fish-like odor prevailed for some time to a most disagreeable extent. While this odor is of most frequent occurrence, others of very different character are occasionally reported. Last year the Bradlee Basin, which supplies a part of the water for Boston, became affected with an odor described as closely resembling cucumbers. None of the other ponds in the neighborhood were similarly affected. About the same time the water of Springfield, Mass., exhaled the odor of green corn. In 1874 the water of Cherbourg, France, became intolerable from an odor undistinguishable from that of a pig-sty. This same odor occurred last summer in Horn Pond, from which East Boston and Charlestown are in part supplied. The odor of decaying wood is not uncommon, especially in early summer." And, in response to a circular letter sent to the various cities of the United States and Canada, the author learned that the fish-like odor was far more prevalent than he had previously supposed, it having occurred in all the following cities: Concord, N. H.; Keene, N. H.; Burlington, Vt.; Boston, Mass.; Lowell, Mass.; Holyoke, Mass.; Brookline, Mass.; Springfield, Mass.; New Haven, Conn.; West Meriden, Conn.; New Britain, Conn.; Hartford, Conn.; Auburn, N. Y.; Newburg, N. Y.; Poughkeepsie, N. Y.; Trenton, N. J.; York, Pa.; Baltimore, Md.; Norfolk, Va.; Nashville, Tenn.; and St. Paul, Minn.

In these letters reference is made to the cucumber-odor, as having been observed at Boston, Springfield, Holyoke, Mass., and at Poughkeepsie, N. Y. In the majority of cases the odor was connected with the increase of temperature in the beginning of summer, and continued only for a week or two. In other cases it began in the autumn, and continued into the winter or early spring. The supply of the cities named is derived from ponds, lakes, and rivers; but it is interesting to note that there is no report of any fish-like odor in the water of any city supplied from the Great Lakes. These odors are extremely volatile; boiling readily expels them, and they gradually escape when the water is exposed to the air.

Hemlock Lake, in Livingston County, New York, situated thirty miles south of the city of Rochester, is about seven miles in length, and has an elevation of about 400 feet above the level of the city. The water is taken from the northern end of the lake, and conveyed in a large conduit-pipe a distance of nearly twenty miles to the main storage-reservoir in the town of West Rush; from here it is carried to the reservoir at Mount Hope, whence it is distributed to all parts of the city. "The difference of elevation between the storage and the distributing reservoirs is 115 feet, and renders it possible, except in winter, to throw up the whole volume of water, as it enters the Mount Hope Reservoir, to a height of about eighty feet, thus

producing a magnificent fountain, which is visible from all elevated points throughout the city. By this means the whole body of water is thoroughly aërated before it enters the distributing mains."

The investigation, which consisted of chemical analysis and microscopical examination, began December 14th. Samples of water were taken from Hemlock Lake, from the chief storage-reservoir, and from the city mains. The analysis, which was conducted with great care, indicated remarkable purity of the water. It should, however, be noted that earlier experiments might have shown a different result. The microscopical investigation was also conducted with scrupulous care, and with such precautions as to preclude the possibility of the escape of any important organism. The total quantity of foreign matter obtained was in each case surprisingly small—"a thousand gallons of water yielding not more than one or two grains of residue, a large proportion of which consisted of minute particles of clay and sand." The facts obtained regarding the fish-like odor were of curious interest. The samples of water taken from the lake and from the reservoirs were found to be entirely free from unpleasant odor, while the fish-like peculiarity was plainly perceptible in the water drawn from the main just before it entered the Mount Hope Reservoir. The odor increased in intensity the farther the water flowed through these mains; so that, in the northern portions of the city, it was very offensive. It is noteworthy that all the water which reached the city had passed through not less than four wire screens with meshes a quarter of an inch in diameter, and in no case had a service-pipe been known to be obstructed by any portion of the body of a fish. "In filtering many thousands of gallons of water, at different times, and under such conditions as to arrest multitudes of the minutest organisms, not the smallest fragment of a bone, or fin, or scale, of a fish—parts which would longest resist decomposition, and float away in the water—has ever been detected."

In answer to the question, "What cause, then, can be assigned for this most peculiar odor?" Prof. Lattimore asserts that it must be due to the decomposition of some form of fresh-water algæ. He draws his conclusions partly from the investigations of others, and partly from his own observation and experiment. After the disappearance of the odor from the water, he observed that microscopic algæ, which had collected on the filters through which water had been flowing for twenty-four hours, exhaled an odor strikingly like that given off by a blade of early spring grass, when crushed by the fingers. A minute quantity of these algæ put into distilled water, and kept covered for a few hours, revealed an odor which was distinctly recognized as that which had recently affected the water from the lake.

This experiment, with others pointing in the same direction, leads to the conclusion that the fish-like odor must be due to some obscure condition of the algæ—most likely to their decay and decomposition.

Concerning the possibility of communicating so powerful an odor to a vast quantity of water by means of an almost infinitesimal amount of algæ, the author says: "That this odorous material was extremely volatile, was obvious. It soon vanished from water left at repose in the open air. Heat expelled it still more rapidly. It was for this reason that no trace of it could be perceived in the open reservoirs where it could escape as rapidly as it was generated, while in the closed conduit from the West Rush Reservoir to the Mount Hope Reservoir, and in the street mains of the city, it was prevented from escaping except when a faucet was opened. Again, in its extreme volatility we have the clearest explanation of the fact that so minute a quantity of odorous material could infect so large a quantity of water. A single flower will instantly communicate its perfume to every particle of the air in a large room. A grain of musk, or a shred of scorched animal tissue, will taint a vast volume of air with no loss of substance appreciable to the most delicate balance."

Regarding the public health, there is no evidence furnished that warrants even a suspicion of any deleterious effect, and this is strictly in accordance with what would be expected if the above explanation is correct.

To the question, "Can any measures be taken to prevent a recurrence of this trouble?" the following answer is made: "It is useless to attempt a reply until we come to understand the causes and conditions precedent to such results. This knowledge can evidently be acquired only by long and patient observation, if obtained at all; and, if obtained at last, it might be only like our knowledge of the laws of meteorology, which indeed enables us to predict the coming changes of the weather with great certainty, but which confers on us no power whatever to control it. On the other hand, it is at least conceivable that, if we understood the life-history of these offensive algæ, and the conditions favorable or unfavorable to their growth and multiplication, we might possibly be able to prevent or favor their growth, or to hasten or retard their destruction in such manner as to prevent the recurrence of the trouble."

A RUN THROUGH THE MUSEUMS OF EUROPE.

By THOMAS M. BREWER.

IN 1875–'76 the writer, having a general interest in the science of ornithology, and making a special study of that somewhat neglected branch which relates to the peculiarities of birds' nests and eggs, devoted, at intervals, more than a year to visiting some of the principal museums of the Continent of Europe, and afterward of

England. Naturally, in these somewhat hasty observations, his favorite departments received the larger proportion of his attention.

It was his fortune to first place his foot on the Old-World soil in the quiet and lovely, the very quaint and very old-fashioned, little city of Bremen, and there to make the acquaintance of two ornithologists whose reputation is world-wide, and who, among the followers of this science, stand in the front ranks—Dr. Georg Hartlaub and Dr. Otto Finsch.

Dr. Hartlaub is a physician, in full practice, standing at the head of his profession, but finding ample time, without neglecting his professional duties, to devote to the study of his favorite science, and to favor the world with valuable contributions, the results of his careful and exhaustive researches. A little past the prime of life, he is still in full and vigorous health. He has made the birds of Africa his principal study. As incidentally attesting Dr. Hartlaub's popularity and high standing among his brother ornithologists, it may be here mentioned that in Gray's "Hand-List of Birds" are no less than twenty-six different species, and one genus, upon which has been bestowed the name of Hartlaub—a compliment that has been paid to no other naturalist, living or dead, not even to the great Linnæus or to the illustrious Cuvier.

Dr. Finsch, though a much younger man, is fully the peer of his distinguished townsman in his reputation in ornithological science. He is the Director-in-Chief of the Natural History Museum of Bremen, which, though by no means among the largest, enjoys the reputation of being one of the most excellent in its arrangement, in Europe. In regard to this, unfortunately, I had not complete opportunity to judge. A new building was in the course of erection on the site of the old museum, and most of the collections, being packed away, were inaccessible. A portion of the birds were open to inspection, and well attested the taxidermic excellence of their preparation, which is said to characterize not only this department, but the whole museum. Dr. Finsch is author of an excellent and, to the student, invaluable monograph on the parrots; and, although he has largely contributed, with Dr. Hartlaub, to investigate the ornithology of Africa, probably there is no one living more generally familiar than he with the ornithological forms of the world. Since I met him he has been absent from home, in charge of an important exploring expedition to the arctic islands, north of Eastern Asia, from which he has recently returned.

Passing from Bremen to Düsseldorf, on the Rhine, our way took us through the old capital of Westphalia, that quaintest of quaint places, Münster; one, too, made so painfully memorable in history by the Vandal acts of the fanatical Anabaptists, and the even more terrible retribution that was visited upon their leaders. There we made a pause, in order to examine a very remarkable private collection of

nests and eggs. It was in the dwelling of one of the prosperous fur-merchants of that city, a gentleman of culture, who, without making any pretensions to scientific attainments, had got together one of the largest and richest local collections in oölogy on the Continent of Europe. It contained between seven and eight thousand specimens, well prepared, carefully arranged, and wonderfully rich in suites and varying sets, of the eggs of European (chiefly Prussian) birds. While I afterward saw other private collections that may contain the eggs of more species, I saw none that so fully presented, in series of sets, the eggs of the birds of any one locality. It was an interesting peculiarity that this collection had been commenced by its owner's grandfather, and three generations had made its increase the amusement and study of their leisure moments. Pains had been taken to note the date of each separate acquisition, and such a collection is thus rendered peculiarly interesting to the student of the local ornithology, on account of the light it cannot fail to throw upon the relative abundance and distribution of the birds of the region. Unfortunately for the student of science, such collections as this are rare and exceptional.

In Berne, the capital of Switzerland, is the National Museum of that republic. This contains an immense mass of materials, illustrative of various departments, some of them in good preservation, but others quite the reverse. A commendable effort had been begun to exhibit all the species of the animal kingdom found in Switzerland, but the space allotted is insufficient; the show-cases are ill arranged, and betray an evident want of funds sufficient to keep up to the highest standard what might have been made one of the finest collections of its kind in the world. One contributor had given to the museum what must have been in its day a very fine collection of the nests and eggs of the birds of Switzerland, including several eggs of that now nearly extinct bird, the lammergeyer of the Alps. Long exposure to the light and dust had rendered the whole valueless.

The geological and mineralogical collections have fared better, and are really very fine. The pure crystals of black quartz are of immense size, and those of clouded topaz are truly magnificent. One cannot doubt the correctness of their claim to be the finest in the world. Crowded into the small apartments of an irregular building, though well worth a noble hall, devoted exclusively to their exhibition and preservation, are some of the most interesting historical collections anywhere to be met with. Besides the relics of the ancient Lake-dwellers, which seem almost to unite the two departments of ethnology and geology, may be seen the remarkable trophies captured by the Swiss in their memorable war with the Burgundians, under Duke Charles the Bold, four centuries ago last summer (in 1476), including a rich altar-piece, and the tapestries and other costly trappings of his regal tent, which are among the most interesting relics to

be found. The wealth of these collections is in painful contrast with the poverty of their surroundings.

Though a little out of the order of our visit, we will now turn to Geneva, where, in the Natural History Museum, we find everything in agreeable contrast with the shortcomings of the National Museum at Berne. The spacious and elegant building is comparatively new, is well arranged for light and the exhibition of specimens, and is pleasantly situated in the midst of a large, open park. Here may be studied the famous conchological collections that once belonged to the Duke of Massena, and which, to the student of this department of science, afford added interest as having been the types for Lamarck's great work. Here, too, is an immensely rich and very interesting collection of fossils, systematically arranged by the distinguished Pictet, and, among them, all the geological types of De Saussure. There is also an immense collection of coleopterous insects. The ornithological collection of this museum is not large, but exceptionally good. The specimens are all excellent, are well mounted, and present several commendable features, rare in Continental collections. The exact locality where each specimen was obtained is carefully recorded, and the local group of the birds of Switzerland forms an interesting and instructive feature. Another not common feature is an excellent, systematically-arranged collection of the eggs of birds. Though, comparatively speaking, not a large one, it is quite respectable even in point of numbers; and, in the care given to its preservation and in its arrangement, it is a model, and almost unique. This department is under the charge of M. Alois Humbert, an excellent ornithologist, whose explorations in Asia have contributed many specimens of great rarity, one of the most interesting being a veritable nest of one of the tailor-birds, so long the subject of unverified description.

In Stuttgart, the capital of Würtemberg, is a very large and valuable Museum of Natural History, that fills twenty spacious rooms in the Building of the Archives. To geologists, and to students of zoölogy and comparative anatomy, its collections in these departments are replete with interest. The collection of birds is very rich in rare African types, but, in the absence of Prof. Krauss, the director, these could not be inspected to advantage. The museum has no collection of eggs, but there is in the little kingdom of Würtemberg probably the largest oölogical collection in the world; the richest in its number of species, and excelling in the rarity and beauty of specimens, and in the extent and fullness of series, exhibiting variations in eggs of the same species. It belongs to Baron von Warthausen, and is preserved in his castle near Biberach. Unfortunately, I cannot speak of it from my own observation, as I had gone far beyond it before my invitation to visit and examine it overtook me in Dresden. It is, however, well known to be of great and constantly-increasing value, containing one-

sixth of all the known species. It is especially rich in African and South American kinds, collected, at great expense, by expeditions sent out by the baron at his sole charge.

In Dresden, world-renowned for its galleries of art, and for museums illustrative of kindred departments, one would naturally look for a correspondingly rich Natural History Museum. Still, small and disappointing as the Dresden Museum of Natural History is, it contains the typical collections in oölogy of the late Dr. Thienemann, and therefore cannot be passed by in total silence. This museum has been recently placed under the charge of Dr. Adolf B. Meyer, a distinguished ornithological explorer in New Zealand, and his accession has already been followed by reconstructions full of promise. The Thienemann oölogical collection is an immense one, has been gathered from all parts of the world, and contains all the types of his illustrated work on oölogy. Unfortunately, in the latter part of his life he suffered his vast collection to lapse into great disorder. He ceased to continue a systematic arrangement; successive additions were but partially unpacked, and the identifications of many forever lost, or rendered doubtful. After Dr. Thienemann's death his family presented his collection, in this chaotic condition, to the Royal Museum, and time has but added to the confusion. Labels have been misplaced, and the best of experts cannot always restore them with certainty. Nevertheless there are still materials for creating by far the largest and richest public oölogical collection in Europe. It abounds in very rare and choice kinds; among others, no less than seven eggs of the ivory gull—an egg so rare that only two others are known to be in any museums, one in Dublin and one in Copenhagen.

The extensive museum of Berlin, owing to the inclemency of the weather and the rooms not being heated, could only be partially and hastily examined. The general plan of arrangement was simple and good, and the specimens appeared to be in excellent condition. It possesses a small but valuable and well-arranged collection of eggs, in which the great point of interest is a series of nests and eggs from Siberia, collected by a man of science exiled to that desolate region; many of these are very rare and unknown to other collections. The mineralogical collection is one of the most extensive on the Continent, and is especially rich in meteorolites. Its great interest centres in the collections brought by Humboldt from Central and South America. Dr. William Peters, a distinguished naturalist, is at the head of this museum, and the ornithology is under the charge of the venerable John Cabanis, who ranks high in his department, and is well known as the editor of the *Journal of Ornithology*.

The Imperial Cabinet of Natural History of Vienna deserves fuller mention than our space permits. Its vast collections would require almost a lifetime to examine exhaustively, and no single volume could do justice to all their various points of interest. Indeed, a

good-sized and condensed volume has been devoted to its collections of birds only and from Brazil alone; and when it is remembered that this collection possesses specimens of 1,200 species exclusively from that region, besides all the collections of the Novara Expedition, and that these are but a portion of the immense whole, some idea may be formed of its magnitude. The museum is also rich in its collections of nests and eggs. Many of these are uniques, and were procured by the Novara and other exploring expeditions. These will remain for the present unarranged, awaiting their transfer to new quarters in an immense building which the Government is now constructing, and which in size and position promises to be one capable of doing ample jusice to this noble collection. In charge of the ornithology is Dr. A. von Pelzeln, a naturalist of high repute, and a most courteous and obliging gentleman. At the time of our visit, the fishes and reptiles were in charge of Curator Dr. Franz Steindachner, a pupil of Prof. Agassiz, and for a while his assistant in the Museum of Comparative Zoölogy at Cambridge. He has more recently been promoted to the post of director-in-chief, a position for which he is most admirably qualified.

The natural history museums of Southern Italy, from Naples to Florence, are almost exclusively devoted to human and comparative anatomy. In the lovely City of Flowers we find, in her Royal Museum of Physical and Natural Science, an institution under the royal patronage, and unique in its character. It is a university for teaching natural history and the physical sciences. Here in the home of Galileo, and where his memory is deservedly held in high honor, astronomy receives its full share of attention. Dr. Parlatore, an excellent botanist and an eloquent lecturer, instructs in botany; and the director of the museum is Dr. Henry H. Giglioli, well known to scientific men as the naturalist of the Magenta Exploring Expedition. This institution is fortunate in having at its head so accomplished a gentleman and so enthusiastic a naturalist, and under his judicious efforts to advance its interests it bids fair to become in all its departments well worthy of the Tuscan capital. Its anatomical collections are already deserving of the highest commendation.

In the little city of Pisa, so attractive to strangers for its architectural peculiarities, is a museum well worthy of attention. To the student of ornithology it is interesting as the home of Suvi, the pioneer ornithologist of Italy. Here is a local collection of birds made by him of exemplary merit. The specimens are arranged in family groups, in small, air-tight glass cases, in each of which is presented a single species in all its varied forms, as modified by age, sex, or season. This includes the nest and eggs, the young chick, the summer and the winter plumage, and all the variations of the sexes—at once a novel, instructive, and interesting feature.

In Genoa the Civic Museum, under the patronage and general di-

rection of the Marchese Giacomo Doria, is a model institution, in view of the general excellence of the plan on which it is conducted. Placed on a high position, commanding a magnificent view over a most lovely landscape, surrounded by beautiful grounds, it is a jewel well worthy of such exquisite setting. The building is large and convenient, the collection one of recent date and well arranged. Its most noteworthy feature is that nearly or quite all the specimens have been obtained by Italian explorers, and all have been precisely determined as to their original locality. The museum possesses very many special rarities, in some instances the only known perfect specimens in existence, as a new and undescribed specimen of a cassowary from the Arroo Islands. Its publications are eminently first class, creditable alike to the liberality of the patrons and the scientific merits of the members of this institution. The director of this museum is a young nobleman of scientific tastes and acquirements, using an ample fortune with liberality and good judgment. He is a direct lineal descendant of the historic Doge of Genoa, a first-cousin to the late Prince Pamphili Doria, of Rome, and a near kinsman of another great benefactor of Genoa, the Duke of Galliera, who signalized the last year of a useful life by the gift of 30,000,000 francs to improve the harbor of Genoa.

Milan is rich in museums and collections of various kinds, both public and private. Its Museo Civico, largely devoted to collections of natural history, and under the direction of Dr. Cornalia, is especially rich in its collection of reptiles, claimed to be the finest in Europe—in that of paleontology, and in its collection of skulls. Its director is a gentleman of high scientific attainment, and has largely contributed to the growth and development of the institution over which he has presided so many years. But to an ornithologist the great attraction of Milan is the unequaled private collection of Count Hercules Turati. His cabinet of mounted birds is the finest, as it is also one of the largest, in the world, and, though there may be several public collections both in America and in Europe that outnumber his in species, there is probably not one that approaches it in the uniform excellence, beauty, and perfection of plumage. There are superb specimens of every known species of the birds-of-paradise, very rare and very costly, and all in exquisite plumage. No expense is spared in procuring additions to this collection. Liberality, courtesy, and devotion to science, confirm this gentleman of rank as one of Nature's true noblemen, and unite with him to render his collection a great attraction to the ornithologists of all Europe.

The Museum of Natural History of Turin was commenced under the patronage of the royal house of Savoy, and is still aided by the Italian Government. But just at present Italy is called upon to expend so much upon her armies and her navies, her railroads and her public schools, that she has but little money to devote even to the favorite museum of her king. Nevertheless, this museum contains much

that is worthy of consideration. The construction of the national railroads of Piedmont enriched its paleontological department with many unique and wonderful relics of the dark ages of geology; and, above all, in its director, Count Tommaso Salvadori, the Museum of Turin possesses one who is conceded to be, *par excellence*, the ornithologist of Italy, and who enjoys a world-wide reputation as among the first in this department of science. The collection of birds is, of course, well arranged and especially interesting in types. At the time of our visit, Salvadori's private room was literally strewed with many hundred specimens of birds-of-paradise, representing all but two or three species of this family, with series by the hundred of several species. These had been recently collected by two Italian travelers, one set belonging to the Italian Government, the other to the Civic Museum of Genoa, and referred to Salvadori for examination, and to aid him in his monograph of this family.

The Garden of Plants, in Paris, is an institution too generally familiar to require more than a passing mention. The new houses for the protection of the living animals are models in their contrivance, more especially the one for the reptiles and batrachians. The Ornithological Museum, though not of itself very extensive, is particularly interesting to scientific students as the depository of collections made by the several national exploring expeditions of France. Among these are many unique and typical specimens, not known to exist elsewhere in museums. The collection of eggs is also wonderfully interesting, is very large and well preserved, and contains not only many very rare kinds, but is especially noteworthy as possessing a large number of species not to be found in any other public collection, some of them laid by birds in confinement.

Leyden, in Holland, could not be passed by without at least a brief visit to the venerable Dr. Schlegel, and the far-famed museum under his charge. The time was, and that not immemorial, when this museum contained the largest collection of birds in the world. Even now it is surpassed by very few, and is still superior to all others in its representations of East Indian species. Its strongest point is its collection of monkeys, to which class of animals Dr. Schlegel has given great attention, and of this our ancestral family—according to Darwin—it possesses the surprising number of 1,500 different species. Dr. Schlegel, though of mature years, is still in vigorous health, a most charming old man, bright, cheerful, and affable, possessing an inexhaustible fund of conversation and knowledge, enriched by the careful observation of a long and well-spent life. His museum possesses a very rich collection of the eggs of the birds of Java and other East Indian possessions of the Dutch.

Of the British Museum, as a whole, it would be impossible to speak from competent knowledge, except with much more time than we could give to so endless a task. The writer will say that all he did or

could see was very disappointing. Its collection of mounted birds, though containing much that was typical, rare, and interesting, was in the individual defects of a large proportion of its specimens in painful contrast to the private one of the Milanese banker. The collections of eggs were not arranged, and had not been procured with any special care. They seemed to have been all accumulated by chance donations, and required an immediate and very careful revision. It is, however, but justice to say that, since the zoölogical portion of the museum has been under the charge of Mr. Sharpe, a systematic rearrangement has been begun, and, so far as it has proceeded, is a great improvement. When the natural history portion of the museum is removed to Kensington, and rearranged in the new building in the course of construction, it is to be hoped that the managers of this institution will avail themselves of their great opportunities, now so strangely neglected, and render this branch of the British Museum better worthy of being the one national museum of a great empire. The contrast between the Museum of London and that of Newcastle-upon-Tyne, or that of Liverpool, cannot but be painful to the national pride of a true English naturalist.

For popular attractions, for general excellence of arrangement, and expedients for the instruction and education of the people in natural history, the Derby Museum, or, as it is now called, the Free Public Museum of Liverpool, far surpasses anything of its kind. It was founded by an ancestor of the present Lord Derby, and is under the admirable direction of Mr. Thomas J. Moore; but it would extend this paper too far to point out the excellence of its various devices for popular instruction. Here you can see the external form of bird or animal, and next to it its own skeleton, so that the bony frame and the outward appearance may be studied at the same moment. In one compartment are a full-grown lion and lioness, and with them young lions of various ages, from the tender nursling to the nearly full-grown whelp. In another compartment is well represented water in which appear disporting various forms of swimming-birds, old and young, demonstrating to the observer their position, when swimming, both above and below the surface. The collections are large and varied, and so arranged as to attract and educate the visitors.

In conclusion, only brief mention can be made of a few of the private collections of natural history in which England abounds. In his private apartments in Hanover Square, London, Prof. Osbert Salvin, of Cambridge University, stores his rich collections of birds, and eggs, and insects, gathered by himself in Central America. They are especially abounding in specimens from Guatemala, are admirably arranged, and well worthy of careful study. Howard Saunders, Esq., who makes the families of gulls and terns his especial study, possesses collections that are indescribably interesting. They consist of the birds (with their eggs) of Europe, together with exotic representatives of the two fam-

lies in which he is chiefly interested. He has been an active explorer in Spain, and the collections made there by himself are the chief attractions of his cabinet. Henry E. Dresser, Esq., a London merchant, and author of a magnificent work on the birds of Europe, now in course of publication, possesses, at his residence on South Norwood Hill, the most complete collection of the eggs of the birds of Europe probably in existence. It is admirably arranged, containing many fine suites of the least common kinds, and very many species not in any other collection.

The collections in oölogy, made by the late Mr. John Wolley, the indefatigable explorer of the ornithology of the arctic regions of Europe, were bequeathed to Prof. Alfred Newton, of Cambridge, who has illustrated them in a publication of great elegance. This collection is of great scientific as well as pecuniary value. Its series of specimens of some of the rarest arctic eggs are immense. The market money-value of one of these series—that of the waxwing—at its lowest computation, is not less than £100.

Within the close of the venerable Cathedral of Durham, the writer was privileged to examine, in the cabinet of Rev. Canon Tristram, the largest collection of eggs it was his good fortune to see in Europe. This gentleman is an excellent ornithologist, has been a great traveler and explorer in America, North Africa, Palestine, Syria, and elsewhere, and his collections, which number over 1,700 species, have been largely taken by his own hand.

And here our space compels us to close our narrative, leaving much that was to us exceedingly attractive unsaid and undescribed. Though disappointing in certain instances, our study of European collections, as a whole, incomplete as it too often was, and all too hurried as to the time allotted, was ever full of instruction, interest, and enjoyment.

THE SEWING-MACHINE IN POLITICAL ECONOMY.

IT is very probable that as we obtain a fuller and more accurate command of facts relating to the production of wealth under perfectly free conditions in countries like our own, where intelligence is widely diffused, it will be found that the methods of most efficient production are those which necessarily contain within themselves the methods of most effectual distribution. It has been customary to assume, or infer, that the laws regulating the production of wealth were one thing, and the laws regulating its distribution were another; so much so, indeed, that while legislation could not interfere with production without doing harm, it might and ought, on grounds of justice and duty, to regulate distribution. There is strong reason to believe

that interference is just as undesirable and pernicious in the latter case as in the former. Given the most efficient production, that is to say, articles produced in the cheapest, swiftest, and most skillful manner by the free competition of invention, capital, intelligence, and industry, and it is true, as a necessary condition of production so sustained, that the wealth created by and arising from it is distributed step by step, as the process goes on, in the most equitable manner among all the parties engaged in the enterprise.

This is a proposition to be tested by facts, carefully put together, not by ingenious argumentation on hypothetical cases; and it fortunately happens that a paper of great ability on "The Sewing-Machine and its Results," contributed by Mr. John Plummer (well known as a high authority on industrial topics) to the "Companion to the Almanac" for the present year (1877), furnishes the precise sort of evidence required.

The sewing-machine first appeared as a practical invention about thirty years ago. Thimonnier, the real originator of the idea, was a Frenchman, and, like too many great inventors, he did not live to enjoy any part of the fruits of his genius. Elias Howe, who followed Thimonnier, was an American working artisan, and found his first real support in England about 1847. At the present time, that is, about thirty years after the establishment of the invention, there are upward of 4,000,000 sewing-machines in use in various parts of the world; and the annual number of new machines produced in this country is estimated at 80,000, employing about 100,000 persons. In France, Germany, and Belgium, the production of machines is very large, and in the United States the annual out-turn of machines is perhaps greater than in the whole of Europe. In 1862 it was estimated that in the United States each machine saved to its owner 50*s.* a week, or say £130 per annum, in wages alone; or an aggregate saving in wages, for the whole country, of about £30,000,000. In 1875, that aggregate saving had risen to £100,000,000.

The facts, therefore, to be considered are imposing by their magnitude, and of high value, by reason of the diversity of the countries and populations by which they are supplied.

Mr. Plummer says: "In England the sewing-machine was first employed in the manufacture of common stays and corsets, of which several million pairs are annually produced. In earlier days the materials were sewed together by needlewomen of the poorest class, principally the wives of seamen and dock-laborers, whose earnings seldom averaged more than 3*s.* or 4*s.* a week. . . . From the stay-trade the sewing-machine found its way into the trades connected with the production of shirts, mantles, dresses, trousers, coats, and other articles of male and female clothing. In some of these trades the needlewomen could not, even by working very long hours, obtain more than 3*s.* or 4*s.* a week, and the public were continually shocked by painful rev-

elations of destitution and misery among seamstresses. Hood's 'Song of the Shirt' expressed the public feeling. Needlewomen's Aid Associations were started, but wholly failed to lessen the evil. . . . *The appearance of the sewing-machine changed all this.* Shirts were made more rapidly and more cheaply than before, but the workwomen were better paid and did not work so many hours. The hours of labor fell, indeed, from eighteen hours a day to eleven or twelve."

The demand for hand-labor increased, because, while the machine did the heavy mechanical part of the work, the cutting out and preparation of the materials rendered necessary more "hands," and a superior aptitude and intelligence. The workers also became to a large extent the owners of the machines worked by them at home; and as the slavery and degradation of the needle became almost abolished, crowds of young women were attached to machine-working by the short hours and the high wages. It is this diversion of female labor which lies at the root of the scarcity of domestic servants, and the extraordinary rise in the wages given to such servants.

Improvements in the machine enabled it to be applied to boots, shoes, harness, and most articles made of leather. In November, 1857, a machine of this kind was introduced at Northampton, and immediately led to organized opposition by the Crispins of that centre of the shoe-trade. This opposition was more or less successful until February, 1859, when the manufacturers of Northampton and Stafford formed themselves into a league, and announced that they were prepared to compel the use of the machines in spite of the opposition of the men. A strike ensued. The men were defeated; and the machines very rapidly revolutionized the whole industry of boot and shoe making. Mr. Plummer says: "With the termination of the strike the operatives became eager to possess machines of their own, and in a short time there were few of the better class of workmen who were not proprietors of one machine or more. These were worked by the female members of their own families, or by women engaged for the purpose." The machines put an end to the more dangerous and unhealthy process of the work. Employers fitted up commodious factories supplied with machines, and hence has arisen the present factory system in the boot and shoe trade, a system as beneficial to the male and female workers as to the capitalists. It is estimated that now at least one-half of the Northampton employers have risen by means of machine-industry from the position of workmen.

Cheapness, rapidity of production, and excellence, led to a vastly increased demand for boots and shoes. Wages were raised; the work was easier; and the buildings in which it was carried on were vastly improved. In Leicester, in 1820, there were 150 operative shoemakers; in 1851 there were 1,375; in 1861, the machine having appeared, there were 2,315; and in 1871 there were 5,703, or nearly four times as many as at the ante-machine date of 1851.

In 1852, says Mr. Plummer, "the average amount of wages obtainable by an experienced female operator was 8*s.* to 10*s.* per week; now the earnings of the female machine-workers are 14*s.* to 16*s.* per week—slower hands get 10*s.*, and the best workers 20*s.* to 24*s.* The female 'preparers' of work get 10*s.* . . . The machine has within a few years been applied to the straw hat and bonnet industry of Bedfordshire, and with the best results. Many of the plaiters who now suffer from Chinese competition, will, as machinists, obtain good wages. . . . In the mantle-trade in London, the wages of machinists are high, say, 14*s.* to 20*s.* for middling hands, and 23*s.*, 29*s.*, and even 33*s.*, for superier workwomen."

As the general result, Mr. Plummer says that, "taking all the various industries in which the machine is used, the wages of the machinists may be estimated as being from 50 to 100 per cent. *higher* than the wages received by hand-workers before the machines appeared in the several industries." And he goes on to add: "The changes introduced by the machine have been attended with considerable advantages as regards the physical and social condition of the workers. There is a great improvement in their health and in the comfort of their homes. As regards the shoemaking population, both male and female, the change amounts to an absolute revolution, and decidedly for the better."

The sewing-machine has most effectually stimulated invention in other directions. In all leather manufactures, for example, the old, painful, unhealthy processes are now nearly all done by machinery driven by steam. In the stay and clothing trades the severe labor of using heavy shears by hand is superseded by steam-driven cutters, by the aid of which one man does the work of twenty. The cheapness arising from these appliances has so enlarged the demand that the quantity of labor employed in the trades is far greater than before.

This is the statement of the facts, and there is no reason to dispute it in any essential particular. The outline amounts to this: About twenty-five years ago the articles produced in all the industries connected with the fabrication of sewed, or "made-up," woven, and leather materials, were dear, and, except in the best instances, of inferior quality; and the laborers, male and female, but especially the latter, were among the worst paid, the hardest worked, and the most unhealthy, in the country. A mechanical invention, called the sewing-machine, of moderate cost and simplicity, was then introduced, the objects of which were, by the application of ordinary labor in private houses or factories, to get rid of nearly all the irksome, slow, and unhealthy processes of hand-stitching, and so by reason of swiftness, exactness, and superiority of manufacture, greatly to reduce the selling-price of the articles offered to the public. The effect of this invention was in a few years to establish two radical improvements throughout

the industries in which it was most successful, namely: 1. The lessened price of the commodities to the consumer, their superior quality, and the circumstance that they were articles required by all, but especially by the middle and humbler classes, at once created an enlargement of demand so rapid and strong that it fully kept pace with the more efficient and swifter means of production; 2. The augmented *gross produce* arising from the decided success of the invention in rendering labor more efficient, in saving time, and improving quality, and reducing the outlay and risks of capital, was divided between the employers and work-people wholly by the operation of natural causes. There was no interference of the Legislature on one side or the other; and practically there was no interference of trades-unions to enforce a minimum rate of wages, or to impose restraints on the skill, industry, and deserts, of the individual male and female laborers. Everywhere there were inferior, middling, and superior laborers, earning corresponding wages; and everywhere the skillful and handiest laborers passed naturally into the class of employers and capitalists. It was a free and wholesome coöperation of capital and labor to supply the best and cheapest articles to the cash demand of a vigorous consumption; and the profits arising from the trade were divided between wages and capital wholly in proportion to the special skill and industry of the individual employers and employed; with the result, as we have seen, of raising wages from 50 to 100 per cent., and adding immeasurably to the comfort, health, and independence of the laborers, but especially of the female portion of them.

But such a result is neither more nor less than *distribution* of the proceeds of production of the most exact and equitable kind. On a large scale the increased quantity of wealth arising from the invention of the sewing-machine has been divided precisely as—on grounds of equity—it is most fit and beneficial that it should be divided; and this equitable and wholesome division has taken place as a *necessary consequence* of the most efficient methods of production being left at perfect liberty, as regards both workmen and masters, to arrive at the cheapest means of commanding and stimulating consumption. If at an early or later stage of the establishment of the sewing-machine it had been possible for the male to exclude the female workers; or, for the two combined to prevent the use of the machine in the houses of male or female workers; or, for any trades-union to enforce a minimum wage, or to impose restraints on individual skill and invention devoted to increase the gross profits—that is to say, the fund alone available for division between labor and capital—it is easy to see that the whole march of the improvement would have been retarded and thwarted. It is clear, also, that the two circumstances which have very materially assisted the success of the machine, as regards both producers and consumers, have been: 1. The small cost of the machine itself, which admitted its effective use in the *homes* of the work-

ers, and in this way has cheapened production by rendering of value the intermittent labor of whole families as it could be spared, and when it could be easiest applied. In this respect the sewing-machine has been the reverse of the former handloom. The machine-workers have prospered because they could take the new invention into their houses without diminishing its force. The handloomers were superseded because the steam-shuttle could not be made a domestic implement. 2. The eminent suitability of female labor to the sewing-machine has secured a class of workers who have had the strongest motives to apply whatever skill and industry they possessed to increase their *piece-work wages* by the extent and efficiency of production. It may be added, indeed, that the great results which have been obtained are among the most cogent illustrations which can be found of the magical influence of payment by results, that is to say, of payment by the piece; for, happily, no other mode of payment has been possible for sewing-machine labor.

The lesson of the whole of this gratifying and hopeful history is, as we said at the outset, that the methods of most efficient production are those which necessarily contain within themselves the methods of most effectual and beneficial distribution: in other words, if we understand and apply thoroughly and truly the conditions which most cheaply, rapidly, and constantly produce wealth, we also, and as a necessary and *pari passu* consequence, understand and apply the conditions which insure the distribution of that wealth among all the parties concerned in the most just and beneficial manner. So far, philosophers and philanthropists have spent their energies in the wrong direction. They have sought for artificial means of what they considered more equal distribution of the products of industry, failing to see that in the circumstances and conditions which render industry on the largest scale most productive there are native and inherent forces which link together production and distribution at every step.—*The Economist.*

CORRESPONDENCE.

HOW A PHILOSOPHIC SKEPTIC WAS RECONCILED TO RELIGIOUS FAITH.

IT has not been usual to regard Herbert Spencer as a reconciler of skeptical minds with religious verities; nevertheless he has labored with great power and earnestness to attain this end, and there has been varied and pointed evidence that this labor has not been thrown away. A letter recently published in the *Chicago Times* states a quite remarkable case of reconversion to Christianity, under the influence of the study of "First Principles." There have probably been many similar cases, though not so conspicuous, and it is not unlikely that there will be a great many more. Perhaps it would be well for our evangelical friends not to overlook this circumstance; and, when they have battered away at hardened old disbelievers in religion with the customary weapons to no purpose, to buy a copy of "First Principles," and, having mastered it, to try Spencer's short method as a last resort. The letter referred to relates to the return of the late Judge Alfred W. Arrington from what is termed "modern infidelity" to the Christian faith, largely through the influence of Mr. Spencer's book. The writer—Mr. C. C. Bonney—was an intimate personal and professional friend of Judge Arrington, and was familiar with the matter of which he writes. Mr. Arrington died in Chicago, December 31, 1867. The communication to the *Times* is as follows.—ED.:

"MR. EDITOR: The *Times* of last Sunday contained a letter written by the late Judge Arrington in 1832, about the time of his renunciation of revealed religion. It is due to his memory that his final return to his early faith be as widely published. In the memoir prefixed to his poems, published after his decease, Mrs. Arrington sketches briefly his religious career, showing him in youth an eloquent preacher, in manhood a truth-seeking skeptic, and at the close of his life a convinced and satisfied Christian. She says:

"'At the early age of eighteen years he commenced to preach, and at that time exhibited an oratoric power that resembled the inspiration of an Italian *improvisatore*. He drew large audiences, and excited the greatest enthusiasm. He continued to preach for several years at intervals, until he lost his childhood's faith; and, after fruitless attempts to find peace in other communions, ultimately abandoned revealed religion. He afterward sought in philosophy a solution of his intellectual difficulties; but, of course, with only partial success. He, however, never abandoned his search for truth. The different systems of metaphysics, from the Indian philosophers down to the latest schools of English positivism, were as familiar to him as the alphabet. The principles of the physical sciences were fully mastered, and their relations to each other and to human life. He sought in every quarter for the knowledge that would enable him to create a sound philosophy of life and morals. . . .

"'The works of Herbert Spencer had a most happy effect upon his mind. He studied them with the greatest delight, and professed to find in them the possible union of science and religion. . . .

"'For some time previous to his last illness, his aggressive skepticism had entirely disappeared, and in various ways he manifested, not only a respect for Christianity, but a strong desire for the gift of faith. This solace was, however, denied him till he lay upon his death-bed, when, to use his own words, "*Like a flash of light, every cloud disappeared, and the vision of Jesus Christ was vouchsafed me.*"'

"I may add to the foregoing extracts that after this event he called his wife to his bedside, and said, among other things: 'Promise me, Leora, that you will assure my friends, especially my professional brethren, some of whom may have been misled by my skepticism, that when I returned to my faith in the Christian religion my mind was not enfeebled by disease, but that my intellect was as clear and strong as ever, and that it was not merely an assent to my early faith, but a conviction as clear as the light of the truth of the supreme miracle of the incarnation. To believe that is to believe all.'

"These are the words as I recall them, and as I believe, if his voice could reach us, he would ask to have them given to the public. His return from infidelity to faith began with his reading of 'The Unknowable,' and particularly the chapter on 'The Reconciliation,' in Herbert Spencer's 'First Principles.'

"I procured and read Mr. Spencer's book at Judge Arrington's urgent request, and learned its effect on his mind in subsequent conversations.

"Some enterprising publisher should give us a new edition of Judge Arrington's writings, with a more ample and detailed sketch of his life than has hitherto appeared. He was a man of extraordinary intellectual

endowments, and the story of his life faithfully told would have all the charm of a noble romance. C. C. BONNEY.

"CHICAGO, *February* 17, 1877."

THE SUN-SPOT PERIODS.

To the Editor of the Popular Science Monthly.

IN the course of an inquiry lately made in reference to the periodicity of cold seasons, and their coincidence with the greatest prevalence of the sun-spots, I came to the conclusion (the reverse of that reached by most of those who have written on that subject) that, while there is a recognized periodicity in the sun-spot maxima, and also a seeming periodicity in the recurrence of cold seasons, the cold winters, instead of falling coincident with, oftenest occur intermediate between, the maxima of the sun-spots.

I think the coldest season of the present century was that of 1816, while the sun-spot maximum for that period is placed in 1817. Another remarkably cold winter, and one of which I have a vivid recollection, was that of 1856; while the nearest sun-spot maxima were in 1849 and 1860. Another unusually cold winter occurred in 1866, almost exactly intermediate between the maximum of 1860 and that which followed.

It seems to be taken for granted that the sun emits less heat during the time it is partially covered with spots. But is this a fact which is substantiated by experiment? It is easy to see that its light may be less; but light and heat, though originating and being propagated similarly, are not identical either in their effects or in the mode of propagation. Thin wave-undulations differ very greatly in length and frequency.

If two liquids of different colors and different specific gravity, and which do not readily mix, be poured into the same caldron, the lighter will rise to and cover the surface. If the one of the least specific gravity be the lightest in color, it will reflect light the most readily; and, if the contents of the caldron be agitated, so that the two liquids be made to show at the surface alternately, the reflection will be alternately greater or less, according as each liquid predominates at the surface.

Suppose that, instead of other agitation, heat be applied to the bottom of the caldron. Gradually, with the increase of the heat, upward jets are produced, and the darker liquid breaks through the lighter surface in the act called boiling. These dark fractures of the light surface—do they not correspond to the sun-spots?

In its ordinary state, the body of the sun is enveloped in, and covered by, an exceedingly bright surface, appearing to be slightly reticulated, called the photosphere. When this photosphere is undisturbed, we have the maximum of light. At other times, apparently by increased internal action, the uniformity of this photosphere is destroyed; titanic forces, acting from beneath, rupture it, and produce what to us is the phenomenon of sun-spots.

Now, is it not logical to infer that the increased action which ruptures the photosphere is accompanied by increased heat-radiation? If it be, there is reason for the cold seasons falling not coincident with, but intermediate between, the sun-spot maxima.

GEO. W. CHAPMAN.

A PRETTY BIG DOG-STORY.

To the Editor of the Popular Science Monthly.

THE perusal of the interesting article on "Canine Sagacity," which appeared in the December number of THE POPULAR SCIENCE MONTHLY, gave me great pleasure, and caused me to recall to memory a very remarkable case of the same character which came under my own observation about two years ago. I was then practising medicine in Galveston, Texas. One day I was called to see a patient, Mrs. Wechsler, the wife of a German butcher. As I entered the hall of the house where she lived, I was met by a large black dog, who under no consideration would let me pass, until Mr. Wechsler himself came to pacify him and assure him that it was all right. The dog then followed us into the sick-room, and, while I was examining the patient, the dog was watching all my movements most attentively. When I departed, I noticed that I was followed by the dog, who did not leave me until he had seen me enter my office. A few days after this the dog entered my office apparently very uneasy about something. The thought struck me at once that perhaps I might be wanted; so I put on my hat and followed the dog, who immediately started for home, where I found Mrs. Wechsler sick in bed, with no one in the house to attend to her. She was surprised at my timely call, and, when I told her that I had been called by the dog, she related to me what was even more astonishing. She had suddenly been seized by a violent attack of vomiting fifteen or twenty minutes previously, when the dog had picked up an empty tin pan and placed it beside her bed, before *running for the doctor*. This dog, who was only eight months old, had never received any kind of training. It is therefore evident that something like the following train of thoughts must have passed through his mind: Seeing me examine the patient and prescribe for her, he must have conceived the idea that I was the proper person to be there when she was sick. Having made up his mind on this

point, the next thing to be done was to find out where I lived; and this he did by accompanying me to my office. Seeing her vomit, he brought her a tin pan, which he probably had seen her use for that purpose, and then set out for my office. The dog called for me a number of times afterward, but never without my services were needed. He was never told to fetch me, but determined himself when it was necessary to do so. Yours, respectfully,

JOHN SUNDBERG, M. D.

BALTIMORE, *December* 4, 1876.

To the Editor of the Popular Science Monthly.

SIR: In an article headed "Over-Consumption or Over-Production?" in your July issue, Mr. Bunce offers an answer to the question, "Why are the times so hard?" taking as his text Prof. Bonamy Price's article, "One per Cent.," which he pronounces to be illogical, fallacious, and based on unwarranted assumptions. It is not easy to disentangle Mr. Bunce's argument, but the following is believed to be a fair statement of the propositions it involves:

1. That the common ideas in regard to national extravagance are erroneous, it being something essentially different from individual extravagance.

2. That wasteful consumption has had nothing to do with commercial distress; that, on the contrary, destruction produces abundance.

3. That no part of the nation's capital has been lost in unproductive enterprises.

4. That the real cause of the trouble is over-production.

5. That the remedy lies in coöperation among producers to regulate production.

A refutation of these propositions is not the object of this letter; all that time and space will allow is to stand them up, stripped of verbiage, and see how they will look.

In the first place, concerning national extravagance, after pronouncing the idea ordinarily held to be "peculiarly erroneous," Mr. Bunce says: "We think it can be shown that expenditure in the case of the individual, and expenditure in the case of a large number of individuals, have certain essential differences, the difference being that the income of the former is absolutely fixed, while that of the latter is wholly expansive." As it stands, this proposition must mean that wastefulness, a bad thing in the case of the individual, becomes in the case of an aggregate of individuals a good thing; it means that, each man's income being fixed, he cannot safely live beyond it; but, if we add together a "large group" of these incomes, they become "wholly expansive," whatever that may be, and cannot be too recklessly spent; it means, in short, that the whole is something totally different from the sum of its parts.

Mr. Bunce tells us that "*a community is rich because it consumes, abundance being the product and consequent of excessive destruction.*" And here is the proof: "It is evident that the immense consumption of coal has made coal cheap and abundant. It has rendered possible the employment of vast capital in the erection of costly machinery for working, transporting, etc. . . . It is true, the consumption of coal is increased by cheapness, but it is only by extravagance that the machinery by which it is made cheap is put in operation. We have an immense wealth of coal because we consume coal so extensively!" This rule, we are told, works in all, or nearly all, our staples, and the conclusion is, "that in all staple things a nation is rich because it consumes." Was ever the operation of the law of supply and demand so grotesquely construed? That the demand for a commodity stimulates the activity of supply is most true, and, where increase is possible, the supply is increased until the widest area of demand is filled at a minimum cost, but it is only by economy that this minimum can be reached. It is surely only necessary to remember that, no matter what the employment of capital or appliance of machinery, every ton of coal moved a foot represents a given unit of force in the total sum available for supplying human needs, and that, when so used, it cannot be applied to other work, in order to see the full absurdity of the proposition that the nation is the richer if the product be wastefully destroyed instead of being husbanded and prudently used!

The third point made, that no part of the capital of the country has been lost in unproductive enterprises, deserves, perhaps, a little fuller attention because of the peculiar reasoning by which it is sought to be sustained. Mr. Bunce says that these works were largely carried on by what he calls "released energy, by labor not otherwise required," and that so far "the community is not the poorer by a mite in consequence." He is willing to admit that, by the purchase of iron abroad, etc., we have lost a part of our "surplus," but he declares that "the assumption that it impaired our capital is wholly groundless." With such a use of terms, it becomes needful to define what is meant by capital in an economic sense, and to point out the difference between it and the capital stock and surplus of a bank or a life-insurance company. The latter are terms used to designate what a book-keeper knows as the fictitious accounts which show the amount of assets of a corporation; it is a purely artificial division which has been

found convenient in keeping accounts, and has no analogue in the accumulations of a community. The word capital, as used by Prof. Price and economists generally, means the nation's accumulated stock of food, clothing, and the other necessaries of life. So long as these commodities remain unconsumed, they are called free capital; when they are employed to sustain laborers engaged in building a warehouse, a bridge, or a railway, the capital is said to become "fixed," or sunk in such enterprise. If the investment is a paying one, returning the cost with interest, the capital is in time released; if it loses money, ultimately becoming worthless, then the capital is fixed forever, or lost. And the true cost of these works to the community is correctly expressed by the price paid for them, Mr. Bunce to the contrary notwithstanding; for, traced to its ultimate source, the cost of the material used is simply the amount of labor that has been put upon it. Of the vast amount of labor which has been so misapplied, not one stroke can be considered as "released energy—labor not otherwise required." It was labor that was needed elsewhere, as is plainly proved, if proof were needed, by the sharp competition and high wages paid for it. But the assertion that there is no labor that could not be put to better use than to throw it away, needs no proof. "But," he asks, triumphantly, "how is it if the savings of a country have been impaired that capital, at the same moment, should be seeking investment at any rate of interest, that all financial circles are choked with an excess of money?"

"When *I* use a word," said Humpty Dumpty, scornfully, to Alice in Wonderland, "it means just what I choose it to mean, neither more nor less." It is only by attributing a similar mental attitude to Mr. Bunce that the confusion of terms which marks his article is to be explained. Capital has been already defined; money, it may be simply said, is a measure of value, a medium, a commodity, at times a transient representative for capital, when there is capital to represent, but either may exist without the other. The reader will excuse these elementary definitions, as they seem to be called for. Savings, capital, money, it is hardly necessary to say, are not convertible terms; and it requires no profound reasoning to show that idle "money"—undoubtedly the immediate result of lessened trade—may find its ultimate cause in impaired savings. It is because savings have been impaired that economy and retrenchment are enforced; it is because people cannot save, and at the same time go on consuming high-priced commodities with the old recklessness, that prices fall and trade operations become restricted and less profitable; it is because commerce no longer offers high-paying investments, that money accumulates in business centres, and is offered, like other commodities, at low prices. And in view of the fact that it is the *cost* and not the *amount* of production that needs to be lowered in order to renew the activities of trade, this is a most cheering sign.

As has been said, the cause of our trouble, as assigned by Mr. Bunce, is over-production. That is to say, too much labor has been usefully employed, too much machinery has been put in motion, too much cotton has been spun, too much leather made—in short, not to particularize, the wants of the people have been too freely supplied. The economist will, of course, admit, as Mr. Bunce says, that there may be over-production of certain things, but the ill effects resulting from undue production of certain things would be partial and localized, and would tend rapidly to correct themselves. Nothing short of general over-production would account for general depression. And so we are brought face to face with the proposition that there is an unhealthy excess of industrial energy in the world, and that it produces more of the necessaries of life than the workers can profitably assimilate!

A few words as to the proposed remedy. Of course, if it be admitted that over-production is the cause, the cure is obvious: it is to check production, and Mr. Bunce does not hesitate to recommend a coöperation of producers for that purpose. The adjustment of industrial activity cannot be left to natural laws, but combinations must be formed which shall see to it that the forge-fires are not relit, and that the idle operative shall remain idle. With millions of laborers waiting for work, this seems like heroic treatment, but there is no way to limit production but to limit the amount of labor employed. And now we begin to see how "peculiarly erroneous" have been the commonly accepted views. The man who makes two blades of grass grow where one grew before; the inventor who, by machinery, increases and cheapens the aggregate of things made; the industrious and frugal operative, who works long hours and saves his earnings—have hitherto been regarded as useful members of society. But this is all wrong; the "tramp" is your true conservator of public welfare. He takes a share in that destruction which leads to abundance, and he at least cannot be charged with contributing to the evil of over-production.

Regarding the example of France, Prof. Price attributes the successful payment of the indemnity to the fact that France had "saved"—accumulated. It would perhaps have been better to say it was because she

had acquired the habit of living within her means; but neither explanation would suit Mr. Bunce, who says it was solely due to the *manner* in which her savings had been held—they had been kept in old stockings, and, when unearthed, enabled the state to pay the German exactions. The admission that "saving" of any kind produced riches that were available under such an unusual strain is fatal to his position; but, passing this, nothing could be more incorrect than the assumption that the enormous levy was paid out of stocking-hoards. Less than ten per cent. of the sum was paid in coin from any source. The indemnity fund was drawn from three sources: 1. The exchanges of foreign trade (i. e., proceeds of *current production*); 2. By selling foreign bonds and stocks held in France (i. e., by converting the accumulated results of *past production*); 3. By money borrowed from foreign countries (i. e., by discounting the proceeds of *future production*). This done, and realizing that, though the levy was arranged, it was not made good, she has gone on producing with unparalleled vigor.

On the other hand, Germany, upon the strength of her acquired millions, proceeded to make serious drafts on her available industry: 1. By the maintenance of a large standing army; 2. By the employment of vast amounts of labor in constructing fortifications, iron-clads, and munitions of war; 3. By unproductive private enterprises, unduly stimulated by speculation. Of course, productive industry must be restricted; commodities have been made costly in price and poor in quality to such a degree that Prince Bismarck declines to allow Germany to compete in the Paris Exposition of 1878, because of the mortification which would result from a comparison of her products with those of other nations. Here, wages have been paid, and wages have been received; that which Mr. Bunce calls "diffusion" has gone on, and, according to his theory of over-production, Germany should have been spared the commercial evils that have been felt in other countries. The fact is, she is worse off to-day than any nation that has a sound currency, and one of her economic writers suggests with some bitterness that the way out of her troubles is to engage in one more war, as the result of which she should have to *pay* five milliards of francs.

E. R. Leland.

New York, *June* 28, 1877.

EDITOR'S TABLE.

CLARENCE KING ON CATASTROPHISM.

MOST of our readers have probably read the brilliant address of Mr. Clarence King on Catastrophism in Geology, recently delivered at the Yale Scientific School, and published in the newspapers. The speaker was fortunate in his topic, which is not only of wide scientific and popular interest, but one to which he has given special study from the American point of view.

When men first began to observe geological phenomena, they were profoundly impressed with the grandeur of their display of power. Rocky masses, miles in thickness, showed that stupendous forces had been at work upon them, upheaving, folding, distorting, and dislocating the mass of strata as if they had been sported with by preternatural powers. Firmly believing that Nature is only about 6,000 years old, all this conjuring with the earth's crust was supposed to have taken place within that time. It was a necessary inference that the forces which had been at work, and the effects produced, were on a scale of magnitude of which people know nothing nowadays. That the world had been drowned in a deluge was deemed certain; and that the whole march of geological transformation had been cataclysmal and convulsive was a natural conclusion. Early geology, therefore, explained things by catastrophes.

But, with the progress of observation and the sobering of the imagination, geologists began to suspect that the notion of catastrophes had been drawn upon a little too freely, and the question arose as to how far causes such as are now in operation can be invoked to explain geological effects. It was recognized as safest to reason from the known to the unknown, and, as the Mosaic barrier gave way, there seemed endless time for the play of geological

changes. It was soon recognized that transformations, such as are now taking place, with indefinite time, might do all that has been hitherto ascribed to catastrophes. A careful study of the varieties and rates of contemporaneous change seemed to establish the conclusion that such action is sufficient to account for all geological results. Those sudden and tremendous demonstrations of which we have no experience were discredited; catastrophes went out of fashion, and uniformitarianism became the dominant idea in geology.

Mr. King holds that this doctrine has been carried too far. Prof. Thompson and his school have tried to corner the geologists on the question of time, maintaining on physical grounds that they must check their periods and duration, which would necessitate the quickening of the activities, and thus induce a return-movement toward catastrophism. Mr. King does not argue the case from this point, but puts it on the ground of direct geological evidence that rates of action and change, of which the world at present knows nothing, have been in play at former times on the American Continent. The following passages are illustrative of his views:

"I have thus hastily mentioned a few of the most important geological crust-changes in America whose rates are demonstrably catastrophic. Besides surface-changes involving subsidence, upheaval, faulting, and corrugation, all of which may be executed on a scale or at a rate productive of destruction of life, catastrophes may be brought about by sudden, great changes of climate, or by intense volcanic energy. In the latter field there are obviously no catastrophes of the first order. Geological maps of the globe have progressed far enough to demonstrate that considerable areas are, and always have been, free from actual ejection of volcanic materials. On the contrary, numerous great regions, notably the western third of our own continent, and the shores of the Pacific, were once literally deluged with volcanic fires. An examination of the ejected rock shows that modern eruptions, by which the volcanic cones of the present period are slowly built up from slight overflows piling one upon another, is not the method of the great Miocene and Pliocene volcanic periods. There were then outbursts hundreds of miles in extent, in which the crust yawned, and enormous volumes of lava rolled out, overwhelming neighboring lands. Volcanoes proper are only isolated chimneys, imposing indeed, but insignificant when compared with the gulfs of molten matter which were thrown up in the great massive eruptions. Between the past and present volcanic phenomena there is not only a difference of degree, but of kind. It is easy to read the mild exhibition of existing volcanoes as a uniformitarian operation, namely, the growth of cones by slight accretions; but such reasoning is positively forbidden in the past.

"If poor, puny little Vesuvius could immortalize itself by burying the towns at its feet, if the feeble energy of a Lisbon earthquake could record itself on the gravestones of thousands of men, then the volcanic period in Western America was truly catastrophic.

"Modern vulcanism is but the faint, flickering survival of what was once a world-wide and immense exhibition of telluric energy—one whose distortions and dislocations of the crust, whose deluges of molten stone, emissions of mineral dust, heated waters, and noxious gases, could not have failed to exert destructive effect on the life of considerable portions of the globe. It cannot be explained away upon any theory of slow, gradual action. The simple field facts are ample proof of the intensity and suddenness of tertiary vulcanism.

"Of climatic catastrophes we have the record of at least one. When the theory of a glacial period came to be generally accepted, and the destructive effects of the invasion of even middle latitudes by polar ice were realized, especially when the devastating effects of the floods which were characteristic of the recession of the ice came to be studied, uniformitarianism, pure and simple, received a fatal blow. I am aware that British students believe themselves justified in taking uniformitarian views of the bowlder till, but they have yet to encounter phenomena of the scale of our quaternary exhibitions.

"A most interesting comparison of the character and rate of stream erosion may be obtained by studying, in the Western Cordilleras, the river-work of three distinct periods. The geologist there finds preserved, and wonderfully well exposed: 1. Pliocene Tertiary river-valleys, with their bowlders,

gravels, and sands, still lying undisturbed in the ancient beds; 2. The system of profound cañons from 2,000 to 5,000 feet deep, which score the flanks of the great mountain-chains, and form such a fascinating object of study, and not less of wonder, because the gorges were altogether carved out since the beginning of the glacial period; 3. The modern rivers, mere echoes of their parent streams of the early quaternary age. As between these three the early quaternary rivers stand out as vastly the most powerful and extensive. The present rivers are utterly incapable, with infinite time, to perform the work of glacial torrents. So, too, the Pliocene streams, although of very great volume, were powerless to wear their way down into solid rocks thousands of feet at the rapid rate of the early quaternary floods. Between these three systems of rivers is all the difference which separates a modern (uniformitarian) stream and a terrible catastrophic engine, the expression of a climate in which struggle for existence must have been something absolutely inconceivable when considered from the water precipitations, floods, torrents, and erosions, of to-day.

"Uniformitarians are fond of saying that give our present rivers time, plenty of time, and they can perform the feats of the past. It is mere nonsense in the case of the cañons of the Cordilleras. They could never have been carved by the pygmy rivers of this climate to the end of infinite time. And, as if the sections and profiles of the cañons were not enough to convince the most skeptical student, there are left hundreds of dry river-beds, within whose broad valleys, flanked by old steep banks, and eloquent with proofs of once-powerful streams, there is not water enough to quench the thirst even of a uniformitarian. Those extinct rivers, dead of drought, in connection with the great cañon system, present perfectly overwhelming evidence that the general deposition of aërial water, the consequent floods and torrents, forming, as they all do, the distinct expression of a sharply-defined cycle of climate, as compared either with the water phenomena of the immediately preceding Pliocene age, or with our own succeeding condition, constitute an age of water-catastrophe whose destructive power we only now begin distantly to suspect."

Having given his reasons for rejecting the idea of uniformity in the course of Nature, especially in Western America, Mr. King proceeds to connect his view with the question of Evolution. It is imputed to him by the newspapers that he arrays Catastrophe against Evolution, to the destruction of the latter doctrine; but this is an error. He labors to show the inadequacy of Mr. Darwin's theory of natural selection to explain organic development; but, as we have said, again and again, Darwinism is not Evolution, and the most eminent evolutionists recognize the tendency to load the law of natural selection with a good deal more than it can carry. Mr. King recognizes that the principle of the "survival of the fittest" is a true principle that has played an important part in organic progress, but which is supplemented by other agencies in the general scheme of Evolution. That Catastrophism is not regarded as fatal to Evolution is at least true of one of its most illustrious representatives, for Mr. King remarks, "Huxley, permeated in every fibre by belief in Evolution, feels that even to-day Catastrophism is not yet wholly out of the possibilities." And speaking of the two theories of unqualified Uniformitarianism and universal Catastrophism (as held by Cuvier), Mr. King declares that he rejects them, and says: "Huxley alone among prominent evolutionists opens the door for a union of the residua of truth in the two schools, fusing them in his proposed 'Evolutional Geology.' Looking back over a trail of 30,000 miles of geological travel, and after as close a research as I am capable, I am impelled to say that his far-sighted view precisely satisfies my interpretation of the broad facts of the American Continent."

In this conception of evolutional geology, Mr. King is led to assign a higher place than has hitherto been allowed to what he terms "evolution of environment," which he regards as a distinct branch of geology that must soon take a recognized form. He assumes a property of plasticity in organisms, by which they are capable of ac-

celerated changes in response to catastrophic disturbances in the environment. Upon this point he remarks:

"It is only through rapid movements of the crusts and sudden climatic changes, due either to terrestrial or cosmical causes, that environment can have seriously interfered with the evolution of life. These effects would, I conceive, be—1. Extermination; 2. Destruction of the biological equilibrium, thus violating natural selection; and, 3. Rapid morphological change on the part of plastic species. When catastrophic change burst in upon the ages of uniformity, and sounded in the ear of every living thing the words 'Change, or die,' plasticity became the sole principle of salvation. Plasticity, then, is that quality which, in suddenly enforced physical change, is the key to survival and prosperity. And the survival of the plastic, that is, of the rapidly and healthily modifiable during periods when terrestrial revolution offers to species the rigorous dilemma of prodigious change or certain death, is a widely different principle from the survival of the fittest in a general biological battle during terrestrial uniformity."

THE LATEST CASES OF HERESY.

THE turning out of the Rev. Augustus Blauvelt, of the Dutch Reformed Church, by the Kingston tribunal, for alleged heresy, is one of the things so common nowadays as hardly to excite notice, and we should probably have heard little of this case had it not been that the theological body saw fit to put the trimmings on to the transaction in a way that was not agreeable to the reverend excommunicate. Not content to depose Mr. Blauvelt from his charge for non-conformity to the creed which he had agreed to uphold, they thought it desirable to give the proceeding an extra touch, and so accused him of betraying his Master. Mr. Blauvelt says that, when he found it impossible any longer to accept the creed to which he had subscribed, he would gladly have resigned, but the polity of the society did not allow it; and when they found it necessary to cut him off, he should have recognized the propriety of it, and acquiesced without protest. But when they proposed to "spot" him, and fasten on him the label of Judas, to save other denominations the trouble of looking into his character and belief, if they were so inclined, he did not assent, but appealed to a higher organization. He thought that, if such an outrage as that was to be perpetrated, it had better not be done in a corner, but by the whole responsible body in a conspicuous place, and where dissenters, if any there should be, might have the credit of favoring fair play. In the final issue, twenty-six men voted that the society had nothing further to do than to exscind the teacher who no longer taught approvingly. But ninety men thought differently, and seemed deeply to feel that every fagot, thumb-screw, and dungeon, of the last eighteen hundred years, and all the instruments and agencies of religious conformity, would be dishonored if this writer of independent articles in *Scribner's Magazine* did not get an extra kick at parting—all that the law allows in 1877.

But with these tactics of the Dutch Reformed Church we are not much concerned: what interests us far more is the initial aspect of the case, or that working of the theological polity which at the outset binds the conscience and fetters the thought of all who assume the function of public teachers, in its jurisdiction. The deeper question is one of religious liberty, of the rights of conscience, and the prerogative of independent expression. From this point of view, other recent cases are of interest.

The Rev. Mr. Miller, of Princeton, got into a dangerous way of thinking for himself, about the creed of his church, and, not being pious and politic enough to crush his rising queries as instigations of the devil, had the honesty to announce some conclusions about the mystery of the Trinity which were unpalatable to the Sanhedrim to

which he was accountable; whereupon they suspended him from the authorized ministerial function.

And now there comes report of another case of specially remarkable features, in Scotland. A distinguished divine has been condemned by his church for heresy in contributing a valuable and important article to an influential publication. The great issue comes out here in a conspicuous and somewhat startling way. It is useless to deny that the most remarkable thing about this age is the activity of inquiry, and the progress of knowledge. More and more, people will scan their traditions, overhaul their opinions, and investigate their truth; and every subject upon which they can hold opinions is undergoing this inexorable revision. The consequence is, that errors are sifted out, beliefs that fail to stand the test are gradually corrected, and knowledge is steadily extended. These processes are so real and so rapid that great works, which represent the general state of thought at one time, in a few years require extensive readjustment. The eighth edition of the "Encyclopædia Britannica," which was published in 1857, was a comprehensive and faithful representation of the state of general thought at that time. But the numerous and important advances of knowledge made since have left it so far behind that it became necessary to reconstruct it. This is now being done, and several volumes have appeared. Among other subjects to be dealt with was the Bible; and, strange to say, there has been a great deal of progress and modification of opinion in regard to the origin, interpretation, and history, of this important work, within the last twenty years. The editors were responsible before the world for the honest and faithful treatment of the subject. There could be no flinching from the duty of a thorough statement upon the subject here, any more than in the departments of physical science. Very naturally the ablest and best-equipped student was sought to deal with so delicate and critical a subject. Prof. Robertson Smith, of the Theological Seminary at Aberdeen, was selected for the duty. It cannot for a moment be supposed that a gentleman of position and ability, such as would be chosen for this work, and writing for the thinkers of the world in so distinguished a publication as the "Encyclopædia Britannica," would fail to treat the subject with the severest care, in the genuine spirit of truth-seeking, and with all the honor of the most elevated scholarship. And such is the character of the essay. It is written with masterly ability, and is so full of interesting and important information with which everybody should be familiar, that we shall print it in full in the next number of THE POPULAR SCIENCE SUPPLEMENT. Yet the Free Church of Scotland has been thrown into consternation by the article, and Prof. Smith has been summoned before the General Assembly and suspended, and it is reported that he is to be formally "tried." Meantime, the world will be interested, and will assiduously read the essay.

Now, we call attention to the contrasted policy of Science in the same circumstances. If we turn to the article "Chemistry," in the "Encyclopædia Britannica," we shall see that here also great advance is indicated. There has, in fact, been a revolution so radical and complete, that those familiar with the old statement may find themselves bewildered by the novelty and strangeness of the presentation. Yet nobody hears about any perturbation or alarm in the chemical world, or about Prof. Armstrong being arraigned before the Chemical Society and suspended for heretical teaching.

Obviously there are here two intellectual procedures, which are not only different, but antagonistic. On the one hand, there is recognition that truth is

the supreme end to be sought; that it is yet but partially known; that doubt respecting its received forms, and the subjection of them to the most inexorable tests, is an imperative duty; and that the noblest mental occupation of man is the free exercise of his powers in questioning received beliefs, on any and all subjects, and attaining to clearer, more elevated, consistent, and valid opinions. It is the office of Science to push destructive criticism to the uttermost limit, in every direction of thought, in the steadfast faith that truth will thereby be the gainer, and views more and more clearly established, against which destructive criticism will be powerless.

Accordingly, in every thoroughly managed scientific school in the world, the students are taught, first of all, to be dissatisfied with things as they find them—are trained to skeptical habits in regard to all that of which the proof is not perfect; and are, moreover, especially required to enforce this discipline upon themselves by questioning the evidence of their own results, and by welcoming from any quarter the hostile criticism that shall overthrow the conclusions they suppose themselves to have established. This is, perhaps, an ideal to which but few scientific students fully attain, both because of its essential difficulty, and because scientific education is as yet but a very partial influence in moulding the mind; while the whole force of current and traditional culture is thrown in favor of a very different system of ideals, ethics, and objects, in the work of mental cultivation.

It is very different in the religious sphere. Theology is older than science, and, by the mass of the people, is regarded as a thousand times more important. Theological teachers have been the great pioneers of education in the past, and are still overwhelmingly in the control of it. Among the presidents of our colleges, where there is one man of science there are ten doctors of divinity. A system of education dominated by theology is one which embodies the theological spirit in its methods of culture. What that spirit is, as respects freedom of thought, and the duty of its teachers in the formation of their opinions, we have seen in the recent treatment, by large and authoritative bodies, of Blauvelt, Miller, and Smith. Truth was not permitted to be their object. The right of private judgment, and the consequent right of the free expression of its results, were made crimes to be punished. The liberty to doubt, and from that starting-point to go on to something more true, is not only not encouraged, but is prohibited.

The newspapers, indeed, say, in commenting upon Mr. Blauvelt's case, that the ecclesiastical decision was right, inasmuch as he had violated his engagements with the Church: he agreed to teach certain things, and was bound by his contract. Possibly; but we protest against this degradation of the function of the teacher, especially on the most important subjects, to that of merely carrying out the literal stipulations of a bargain. Commerce may require this, but it is not favorable to the attainment of religious truth. Where would the Protestant Reformation have been, if this theory of religious contracts had been strictly adhered to? And what is the meaning of religious liberty, if those who teach religion are not to be allowed to think? Moreover, as men can no more help thinking than breathing, what is to become of the religious conscience, if they are not allowed to utter what they think?

But granting that men must fulfill their obligations, the deeper question then arises as to their right to assume such obligations. The theological policy being fixed, what right had either Blauvelt, Miller, or Smith, to subject himself to it, so that by the legitimate and independent exercise of his own

mental faculties he should be liable to be cast out of his communion as an heretical culprit? What right had they, or what right has any man, to assume that a statement of doctrine at any time is final, and to enslave themselves to its life-long acceptance? This question is one for theological students, and if the decisions at Kingston, Princeton, and Aberdeen, are to be taken as indicating the authorized policy of the orthodox world, the young man who contemplates entering that field of labor should make up his mind whether he is prepared to cut himself off from the spirit of the age, to abjure the pursuit of truth, and sink into the office of a mere passive repeater of cut-and-dried formulas, prescribed to him by the powers to which he contracts allegiance. He must understand that the less he can have to do with science the safer it will be for him. Its spirit will rebuke him at every step. He will have, moreover, to learn that theological science, so called, is a misnomer and a mockery. Where the scientific element enters, movement begins, and progress ensues. It implies intellectual activity, free questioning, escape from error, and advance to new conclusions, and upon all this, from present indications, there remains the interdict of theological authority, paralyzing free thought, just as it did centuries ago.

We print an essay of Dr. Coues, the naturalist, which will sufficiently vindicate scientific men from the imputation of not doing honor to the regal faculty of imagination. No brain-cracked poet could go further in rhapsodical glorification of the image-making power of the mind than this devotee of observation and induction. What more can be asked to disprove the alleged arrogance of scientists, and to establish their character for humility, than for one of their eminent representatives to go over into the midst of the guardians of all that is most exalted and ennobling in intellectual effort, and say to them, "One excellent and most useful purpose which the imagination subserves at the hands of the gifted few whom the higher development of this faculty makes leaders of thought, and watchful guardians of human progress, is, to put men of science on their proper level, and to teach them to know their place?" Various queries might arise at this point, but as the doctor evidently went over to the literary society to unbend, and have a frolic of fantasy in their direction, he probably thought it not worth while to take his logic along, and spoil the fun. And so nothing remains but to improve his wholesome lesson.

LITERARY NOTICES.

The Cyclopædia of Education: A Dictionary of Information for the Use of Teachers, School-Officers, Parents, and Others. Edited by Henry Kiddle and Alexander J. Schem. Pp. 868. Price (cloth), $5. (Sold by subscription.) New York: E. Steiger,

It is a curious fact that, while the educated class in England and this country have been for a hundred years making cyclopædias on all sorts of subjects for other people, they have only just now succeeded in getting one for themselves. Lawyers, doctors, clergymen, architects, engineers, and farmers, all have their alphabetical summaries of special knowledge for ready reference, until such works have long since come to be indispensable; but only this year have we first got a cyclopædia of education in the English language that will give teachers, school-boards, and all interested in the subject, available and easy command of the wide range of information which bears upon the vocation of instructor. The explanation of this tardiness is not obvious, for no subject is more amenable to this mode of treatment, and certainly none more imperatively requires it. But it does not much matter how long the work was delayed, now that the want has been so adequately and admirably supplied by the work before us. The editors have been equal to their formidable task,

and have laid out the enterprise on a comprehensive and judicious plan, and have brought their own ability and experience, aided by the best talent in the country, to the execution of it.

There is difficulty, in our space, in reviewing a work so elaborate as this, and so packed with attractive statements that one is tempted to read it through like a history; and all we can do is to convey to our readers some idea of the quality and scope of its contents. Among the subjects systematically and prominently treated are: 1. The Theory of Education and Instruction, embracing, under numerous headings, a statement of the principles that have been arrived at by scientific inquiry and practical experience for guidance in the work of teaching. These results apply to all the grades of instruction and training, from the Kindergarten up to the university. 2. The Organization and Management of Schools, including discipline, class-teaching, and the art of instruction, or the general subject of school economy. These topics are considered with the fullness that their obvious importance requires. 3. Careful attention is given to the administration of schools and school systems, embracing supervision, examination, school hygiene, school architecture, etc. 4. State Policy in relation to Education, a subject of peculiar importance in this country, not only because of the extent of legislative control over the subject, but because of the diversity of government action in the different States. 5. Much space is devoted to the history of education, both the general history of school methods and institutions in different parts of the world, and particularly the history of the school systems in the different States and Territories of this country. 6. Biographical Notices of Eminent Educators form a distinct and very attractive branch of the work. 7. The Statistics of Education, or the data of its extent and progress, are comprehensively presented. 8. The subject of Educational Literature forms a very interesting feature of the work, and is ably handled. Of this the editors say: "As the immense mass of material to be condensed within the compass of a single volume has necessitated the greatest possible brevity, references are made throughout to standard works on educational science, as well as to statistical works, affording more detailed information. It is believed that this will prove one of the most valuable features of the work."

Besides these leading topics, which are treated methodically in their various aspects, a great number of miscellaneous subjects pertaining to human culture are so fully presented as to enrich the volume and greatly to increase its efficacy as a reference-book for the teacher. The perusal of various articles, which may be taken as representative, has satisfied us of the painstaking assiduity and excellent judgment of the editors in carrying out the project. They are not only the first in this country to do the work, but they have evidently done it so well that there will be no necessity of again attempting it. "The Cyclopædia of Education" should be in every library, and in the hands of every teacher. We may add that the work is handsomely printed, neatly and substantially bound, and forms an inviting volume that is not too unwieldy for habitual reference. It is sold exclusively to subscribers, and can be had only from the special subscription agents, or from the publisher.

RECONCILIATION OF SCIENCE AND RELIGION. By ALEXANDER WINCHELL, LL. D. New York: Harper and Brothers. Pp. 403. Price, $2.

THE question of the relations of science and religion receives a new treatment in this interesting volume. Though the title of his book brings into prominence the idea of peace, or of a terminated conflict, yet the work itself, it must be said, is mainly occupied with the antagonism. The warfare is historic and a living struggle of to-day; the reconciliation a promise of the future. But, in respect to the questions at issue, Dr. Winchell claims to take a non-partisan attitude, favorable to a calm and fair survey of the field of controversy. At any rate, he does not try to end the strife by belittling it. The opposition between religion and science is not illusive; he recognizes its reality, its extent, its importance, and its difficulties. He seems, indeed, to regard it as a part of the great system of conflicts and counteractions in Nature, such as attraction and repulsion,

polar antagonism, centripetal and centrifugal forces. The intellect which gives origin to science, and the sentiment of faith, or instinct of worship, which gives origin to religions, work in opposite spheres, and work against each other by action and reaction in historic periods, which the writer designates as psychic cycles. How deep is this necessity of contest, and how wide its field of operation, in the author's opinion, may be gathered from the following opening passage of Chapter II.: "I have attempted to show that the essential natures of the religious and the intellectual forces in man foreordain a species of antagonism; that this perpetual antagonism is not, nevertheless, an abnormal condition, but a grand example of the universal economy of God, who has ordained antagonism as the condition of progress in the natural and the moral worlds. I have deduced from the necessary relation of the ethical and cognitive powers a necessary series of oscillations in the relative dominance of religious and intellectual influences in the lives of men; and have indicated that the exponent of these oscillations has been, as it must be, a series of alternating periods of religious and of intellectual activity and progress. Such alternations, since the antagonizing forces belong to humanity as such, must characterize the history of all nations, all races, and all times."

He then proceeds "to show that the facts of the religious and intellectual history of the human race illustrate and confirm these deductions, and become in reality a broad inductive basis on which these propositions may be rested as valid generalizations. A prolonged and attentive study of the facts which make up the religious and intellectual history of our race has caused my attention to be directed to the following facts subsidiary to the general induction: 1. Religious faith recedes from its normal condition to one of abnormal subordination, or advances to one of abnormal supremacy; 2. Intellect from its normal condition either advances to a haughty dictatorship or falls into a condition of servitude; 3. These movements of faith and intellect are reciprocal and responsive; 4. The direction of the movement is determined by the initiative: if faith lead in activity, a religious phase succeeds; if intellect take precedence, religious pretensions shrink, and an intellectual phase succeeds. The two phases complete a psychic cycle." Four of these psychic cycles are traced in the course of Christian history.

This is an original and ingenious conception by which Dr. Winchell is enabled to group and arrange the elements of his discussion, historic, religious, philosophic, and scientific, in a very instructive manner for his purpose, and on this account the exposition is certain to be read by general students with interest and profit. Dr. Winchell's work will do especial service, among religious readers, by making the whole discussion, as we might say, a piece of natural history; that is, he treats it in both its aspects, as a part of the method and phenomena of Nature. While holding to the inspiration of the Bible, and the supernatural claims of Christianity, as matters of his own special faith, he nevertheless holds to the validity of the universal religious sentiment in man, and which is as much a subject of rational inductive inquiry as are the physical sciences themselves. We can hardly overrate the gain thus secured, by bringing the whole inquiry into the scientific sphere, and conducting it in the broad judicial spirit which genuine science always imposes.

In one respect, we think Dr. Winchell's work is open to critical objection: it fails to state, as fully as the subject requires, the bearing of the doctrine of Evolution upon the questions in issue. He gives a cautious adhesion to the biological aspect of this theory in the following passage from the preface: "In reference to the much-mooted scientific question of the derivative origin of species, the reader will detect indications of a growing faith. A certain class of proofs has been accumulating at a rapid rate; and the author's present conviction is, that the doctrine of the derivation of species should be accepted."

Now, if the doctrine of descent, as here referred to, is to be accepted at all, it is on the ground of its truth; and, if it be true, it does not stand alone or as a proposition with which we have no further concern than simply to approve or reject it.

If the origin of species by derivation is established, it goes a great deal further and gives us the origin of many more things. It must be taken as an indication of the plan of Nature, of which man is a part, so that the career of humanity is at once brought under the law of development. If there be truth in evolution, we are bound to go by it; and if man's religious nature has had an unfolding, like the other elements of his being, that fact must certainly be of the greatest moment in determining the relations of religion and science. As to harmony or conflict, the question at once arises at what stage it is taken, and what are the traits of that change in which man's religious progress consists. Dr. Winchell, as we have said, affirms the universality of the religious element in man, and deduces its validity from its universality, but he ought to have eliminated from it the transitory, or what can be outgrown, and told us what there is about it that is essential and permanent, and to be finally harmonized with science. He enumerates the following as the grand facts common to the religious faiths of the world: 1. A Supreme Being, the author of all things in existence; 2. A revelation of the Supreme Being either in sensible things or in the intelligence of inspired men; 3. A system of worship—which is either instinctive and aimless, or intended to propitiate the Deity and win happiness for the worshiper; 4. Prayer, the universal cry of humanity in distress; 5. Future existence; 6. Moral responsibility; 7. A system of future rewards and punishments; 8. A priesthood charged with the direction of religious ceremonies, and clothed with a special investiture of divine authority and power. He says: "These facts I find to be the constants in the varying faiths of mankind. I will add that two other facts reveal themselves in *most* of the religious systems of the world—both the greater and the less. These are: 1. A belief in the efficacy of vicarious expiation; 2. An expectation of a Redeemer."

These are, no doubt very widely-spread beliefs, but they have had very different meanings among different races, and at different times. In this field, preëminently, we are familiar with the decay of the vital core of beliefs, and the conversation of their formulas, but what we want most to know is, the laws of change, transformation, and expansion of religious ideas, in relation to man's intellectual development — what falls away and what survives. Dr. Winchell recognizes the progress, and gives us the final result, in a form so generalized, that we can only find the constants just named by some stretch of implication. He says: "The next psychic cycle, it seems to me, will witness a synthesis of thought and faith—a recognition of the fact that it is impossible for reason to find solid ground that is not consecrated ground; that all philosophy and all science belong to religion; that all truth is a revelation of God; that the truths of written revelation, if not intelligible to reason, are nevertheless consonant with reason; and that divine agency, instead of standing removed from man by infinite intervals of time and space, is, indeed, the true name of those energies which work their myriad phenomena in the natural world around us. This consummation—at once the inspiration of a fervent religion and the prophecy of the loftiest science—is to be the noontide reign of wedded intellect and faith, whose morning rays already stream far above our horizon."

TURKEY. By JAMES BAKER, M. A. New York: Henry Holt & Co. Pp. 495. Price, $4.

THE problem of the Turkish Empire, the great anomaly in European civilization, has long occupied the attention of those interested in international politics—an interest greatly heightened, of late, by the Russian invasion of Turkey, and the threatened complication of other states in the struggle. To those whose solicitude about the Oriental question leads them to inquire into the condition of the people most deeply concerned the present volume will be eminently welcome. We lately called attention to Mr. Wallace's admirable book on "Russia." Colonel Baker's volume gives us a corresponding picture of Turkish life and character, the political institutions, religious peculiarities, and material resources of the empire. The book is full of very interesting information upon this class of subjects, much of which is fresh, and calculated to

dispel erroneous impressions, and many unjust prejudices that are entertained in Christian countries, concerning the Turkish people. Turks are known to the outside world chiefly through their government, which is bad and corrupt, and shamefully misrepresents the population which it rules. After sketching some historic features of Turkish character in former times, in Chapter VIII., Colonel Baker goes on to say:

"There is one point in common with both the past and the present, and that is that the Turkish rank and file, the real pith of the nation, were then, as now, distinguished for their patience, discipline, sobriety, bravery, honesty, and modesty, and to these qualities I may also add that of humanity, although I know it will excite an indignant exclamation from many at the present moment. But look at the Turkish soldier in private life, and you find him gentle and kind to children and women, and exceedingly fond of animals. His first thought after a long and tiring day's march is his horse. As soon as he has made the animal comfortable, then he thinks of the man. When he is exasperated by what he thinks insults to his creed, he kills and slays as his teaching tells him, and he appears a fanatical madman; but he is then outside his real nature, and not within it. It is but the other day that I saw thirteen thousand of these brave men arrive fresh from the front and all the hardships of the Servian campaign. They were billeted for ten days all over the town of Salonica, and there was not a single complaint, or cause for complaint of their conduct, from man, woman, or child.

"The streets, although filled with soldiers, were as quiet as in ordinary times. What other troops *in the world* would behave in such an admirable manner? Read the greatest authorities on the subject. Von Hammer, Gibbon, Boué, Ubicini, Creasy, and all agree in praise of both the past and present character of the Turkish rank and file. But it is the rank and file that depicts the character of the nation, and not the corrupt oligarchy, which from its prominence misrepresents it. We find, then, that the rank and file of the Turkish people is the same now as ever, so that it is not the nation but the rulers which have changed, and this change has been brought about through the corrupt influences which were handed over to them by the Byzantine Empire.

"As soon, therefore, as the head of the Turkish nation shall be purified, we shall find the whole constitution in a healthy state—there is no disease of the body. The combination in Turkish government of despotism with the freedom of the most democratic of republics is unique. In Turkey there is no aristocracy. All men below the sultan are equal, not only in the eyes of the law, but by creed and custom. A shoeblack may be made grand-vizier, and it is by no means uncommon to see some of the highest officials of the state who have been servants to predecessors in office."

The volume is written in a pleasant, unambitious style, the writer's object being evidently to tell the story of the Turks in a plain, direct, and instructive way.

ELEMENTARY CHEMISTRY: A Text-Book for Beginners, designed as an Introduction to Barker's Chemistry. By S. F. PECKHAM, A. M. Pp. 254. Price, $1. Louisville, Ky.: John P. Morton & Co.

THIS is a neatly-bound, neatly-printed, and neatly-illustrated school-book, designed for beginners; and the author says that his "object has been to supply a work for elementary schools which should be as nearly as possible equal in quality to the text-books of Barker and Eliot and Storer." He could not have taken better models. A peculiarity of the book is, that the work of learning and instruction is carried on by the artifice of conversation between Harry, George, Lucy, and Uncle Louis, which raises the question whether much of their talk is worth the space given to it. The illustrations run into the pictorial, regardless of the publisher's purse, and it is an aim of the writer to make the book introductory to agricultural studies.

THE FORCES OF NATURE: A Popular Introduction to the Study of Physical Phenomena. By AMÉDÉE GUILLEMIN. Translated from the French by Mrs. Norman Lockyer, and edited, with Additions and Notes, by J. Norman Lockyer, F. R. S. Illustrated by nearly 500 Engravings. Part I. Pp. 40. Price, 40 cents. London: Macmillan & Co.

THE great success of the elaborate volume under the foregoing title, both in France and England, has induced the publishers to enter upon its reissue in parts, with the view of cheapening it, and bringing it to the attention of a wider circle of readers. It is hardly necessary to repeat what we said in reviewing it, that the book is superbly illustrated, and is very clear and popular in the style of its text. It will be completed in eighteen parts.

TRANSACTIONS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS. Vol. III. 1875–'76. Pp. 269.

THIS volume of 269 pages comprises twenty-four papers read before the Acad-

emy, of which thirteen were read before the department of the natural sciences. Several of these illustrate the geology and natural history of Wisconsin, but are of general as well as of local interest. Others give the results of archæological researches in the State, with several illustrations.

The departments of letters, of the social and political sciences, and of speculative philosophy, are represented by papers of ability from specialists in the respective departments. A paper on recent progress in theoretical physics by Prof. John E. Davies, of the University of Wisconsin, is an able *résumé* of researches on that subject.

A summary of proceedings of the Academy since 1874 is given, and not the least interesting portions of the volume are memorials commemorating the labors and worth of two deceased members, the late Prof. Peter Engelmann, and the eminent Dr. J. A. Lapham, first secretary of the Academy.

A Course of Lessons in Modeling Wax Flowers, designed especially for Beginners. By Florence I. Duncan. With Illustrations. Philadelphia: J. B. Lippincott. Pp. 94.

This little book is intended as a practical guide to the art of modeling flowers in wax. The author aims to give such explicit directions for the selection of materials, and their proper manipulation, that a novice in the art can acquire dexterity in the management of wax for this purpose. It is well gotten up, is attractive in its general appearance, is printed on fine thick paper, and illustrated by seven full-page engravings of flowers suitable for models.

Catalogue of the University of Cincinnati for the Academic Year 1877–'78. Pp. 104. Office of the University.

This young institution gives indications of vigorous life and thorough-going management. Its scientific department, especially, is administered with ability. Chemistry, for example, is not only taught in the sense of imparting existing knowledge, but the students are early called upon to address themselves to original and independent work. There are gaps, unsettled points, contested questions, and doubtful results, in such abundance in this science that there is no difficulty on the part of the intelligent teacher in assigning problems suited to various capacities and steps of advancement, or in combining a class upon any suitable line of investigation. Prof. F. W. Clarke, who has charge of physics and chemistry, has arranged a course of preparative work along the track of chemical physics, which is well fitted to train the students to habits of accurate manipulation, and to stimulate them in the direction of original thought. One feature of his plan is thus presented:

"In connection with the other laboratory exercises, a certain amount of time will be spent in making fine chemical preparations, and in determining densities. In 1877–'78 this portion of the course will be so arranged as to involve the coöperation of all the laboratory students in a systematic research upon the constitution of double salts. Each student will be required to prepare a number of such salts, and to determine, by means of the specific-gravity bottle, the amount of condensation which takes place during their formation. At the end of the year the entire mass of material thus collected will be discussed both by the student and by the professor, and as much of it as proves to be valuable will be published in some one of the scientific journals. The aim of this exercise is to give every student some insight into the methods pursued by scientific investigators, and to demonstrate the important principle that whoever is able to study science at all is also able to contribute something toward its advancement."

The Anonymous Hypothesis of Creation. By James J. Furniss. New York: Charles P. Somerby. 1877. Pp. 54. Price, 50 cents.

In this review of the Mosaic cosmogony, the author aims at presenting the subject as concisely as practicable for the benefit of those who have not the time or the inclination to peruse more voluminous works. The first and second chapters of Genesis are dissected and compared, and their supposed incongruities are rendered more obvious by being presented in tabular form.

A Calendar of the Dakota Nation, by Brevet Lieutenant-Colonel Garrick Mallery, U. S. A., from the Bulletin of the United States Geological and Geographical Survey. Pp. 25.

Colonel Mallery, with the assistance of Lieutenant Reed and others, whose services are acknowledged, has presented a valuable paper, with a lithographic copy of the Dakota calendar. The original is on

cotton cloth, and represents, by a series of symbols, events in which the Dakotas were concerned, beginning about the year 1800. Each year is represented by a symbol, the meaning of which is explained in the text. The symbol for 1800 is thirty black lines, representing that thirty Dakotas were killed that year. The symbol for 1801 is the head and body of a man covered with red blotches; that year the small-pox broke out in the nation. In 1869 the sun was eclipsed; the symbol representing it is a black disk. The calendar is of value as "an attempt, before unsuspected among the nomadic tribes of American Indians, to form a system of chronology."

THE DEVELOPMENT OF THE ANIMAL KINGDOM: A Paper read at the Fourth Meeting of the Association for the Advancement of Woman. By GRACEANNA LEWIS. Pp. 21.

THIS paper is an attempt to show that there exists an "order of relationship" in the animal world, and that, beginning with the lowest organisms, there has been, up to the highest forms, an "order of development." The facts which recent paleontological researches have brought to light are used by the author with considerable skill in illustration of her subject.

PERSONAL IMMORTALITY, AND OTHER PAPERS. By JOSIE OPPENHEIM. New York: Charles P. Somerby. Pp. 98. Price, $1.

THIS little work is by an avowed free-thinker, who, in a few pages of prefatory remarks, tells us in a very candid way why she thinks such a book is needed, and what she hopes to accomplish by it. Then follow discussions of "Personal Immortality," "Materialism," "Prayer," etc. The spirit of the writer is good, and, whether readers agree with her views or not, they cannot deny her sincerity or fail to be gratified by her tolerance.

WESTERN DIPTERA. By C. R. OSTEN-SACKEN. From the Bulletin of the United States Geological and Geographical Survey, Vol. III., No. 2. Pp. 164.

VERY little was known of the diptera of the Pacific coast until the publication of this report. Collections were made by the author in California during the years 1875 and 1876, not only along the low plains, but on plateaus of the Sierra Nevada region, at elevations of from 6,000 to 8,000 feet above the level of the sea. The present volume is a survey of the collections made, which the author says are, after all, but a small fragment of the fauna collected during a limited season. The descriptions of families and species are full and clear, and the volume, which comprises 165 pages, will be prized as a valuable contribution to American entomology.

REPORT ON THE MINERAL WEALTH, CLIMATE, AND RAINFALL, AND NATURAL RESOURCES, OF THE BLACK HILLS OF DAKOTA. By WALTER P. JENNEY, E.M., Geologist in charge. Pp. 71.

THIS report, published in 1876, comprises Chapters V., VI., and VII. of the forthcoming final report of the exploration of the Black Hills, made under direction of the Commissioners of Indian Affairs, in 1875.

The area of the Black Hills is stated to be nearly 6,000 square miles, about two-thirds of which area is in Dakota, the remainder in Wyoming. They are separated from the main chain of the Rocky Mountains, and surrounded by level or rolling plains. The mineral and agricultural resources, climate, rainfall, water, forests, etc., of the Black Hills region are presented in considerable detail. A good map accompanies the report.

FIRST ANNUAL REPORT OF THE OHIO STATE FISH COMMISSION. Columbus: Nevins & Myers, State Printers. 1877.

IN this report is given a detailed and very interesting account of what has been done by the Ohio State Fish Commission to promote the culture of fish in that State. Hatcheries have been established at Castalia Springs, Toledo, Cleveland, and Kelley's Island, at all of which places the hatching of fish has been successfully carried on. The report is greatly enhanced in value by numerous illustrations, which are accompanied by very full descriptions, copied from the manuscript of Prof. Jordan's forthcoming report on the zoölogy of Ohio. The report includes a catalogue of the fishes of the State.

SHADE-TREES, INDIGENOUS SHRUBS, AND VINES, by T. STEWART, M. D., and INSECTS THAT INFEST THEM, by Miss EMMA A. SMITH, Entomologist. Peoria, Ill.: Transcript Company. 1877.

THIS pamphlet was prepared for the region about Peoria, Ill., but contains much that will be of value elsewhere. It gives a brief account of the indigenous trees and shrubs best adapted to the locality, and the paper by Miss Smith treats of the insects which infest them, of which figures are given. Publications like this do excellent service in directing public attention to the cultivation of trees and the planting of forests.

SCIENCE-LECTURES AT SOUTH KENSINGTON. London and New York: Macmillan.

UNDER the above general title Macmillan & Co. have published a series of small volumes containing lectures delivered at the South Kensington Museum during the loan collection of scientific apparatus last year. One of the volumes contains two lectures by Prof. Roscoe on "Technical Chemistry," the first treating of the manufacture of sulphuric acid, and the second of the alkali manufacture. In another volume are two lectures by Prof. Stokes, on "Absorption of Light and the Colors of Natural Bodies," and on "Fluorescence." The third volume of the series contains two lectures on the "Steam-Engine," by F. J. Bramwell. Finally, there is a volume entitled "Outlines of Field Geology," by Prof. Geikie. These lectures are all addressed to science-teachers, and not to popular audiences; hence they are rather technical, and possess an interest for the practical student of science rather than for the general reader. The prices are: for the first two volumes, 20 cents each; for the other two, 25 cents.

J. W. BOUTON announces "Isis Unveiled: A Master-Key to the Mysteries of Ancient and Modern Science and Theology," by H. P. BLAVATSKY, Corresponding Secretary of the Theosophical Society. This work is announced as a philosophical study of Orientalism, by a native of Asia, whose life has been passed in the study of traditions, languages, literature, mythology, philosophy, and mysticism, of Eastern peoples, and who considers Oriental thought and history with reference to modern ideas. The work is to be issued in two large octavo volumes.

PUBLICATIONS RECEIVED.

Narrative of the Polaris Expedition. By Rear-Admiral C. H. Davis. Washington: Government Printing-Office. Pp. 696. With numerous Plates.

Hand-book of Descriptive Astronomy. By George F. Chambers. London and New York: Macmillan. Third edition. Pp. 960. Price, $10.

History of Protection in the United States. By W. G. Sumner. New York: Putnams. Pp. 64. Price, 50 cents.

Lists of Elevations West of the Mississippi. By H. Gannett. Washington: Government Printing-Office. Fourth edition. Pp. 164.

The Tailed Amphibians. By W. H. Smith. Detroit: *Herald* print. Pp. 158.

Eighth Annual Report of the Massachusetts Board of Health. Boston: Wright print. Pp. 523.

Bulletin of the Geological and Geographical Survey of the Territories. Vol. III., No. 3. Washington: Government Printing-Office. Pp. 200.

Relations of the Public School to the Negro. By Civis. Richmond: Clemmitt & Jones print. Pp. 39.

Scientific Basis of Delusions. By Dr. G. M. Beard. New York: Putnams. Pp. 47. Price, 50 cents.

Pennsylvania College Monthly. Gettysburg: Wible print. Pp. 96. Price, $1.25 per annum.

Semicentennial Anniversary of Prof. J. W. Jackson at Union College. Albany: Munsell print. Pp. 32.

Reply to a Printed Circular. By Dr. J. Marion Sims. New York: Kent & Co. print. Pp. 24.

Influence of Physical Condition on the Genesis of Species. By J. A. Allen. From the *Radical Review*. Pp. 32.

Twenty-eighth Annual Announcement of the Woman's Medical College of Pennsylvania. Pp. 20.

Recent Progress in Sanitary Science. By A. R. Leeds. Salem Press print.

Papers on the Coryphodontidæ, the Odontornithes, and a Gigantic Dinosaur. By O. C. Marsh. From *American Journal of Sciences*. With Plates. Pp. 8.

Responsibility in Parentage. By Rev. S. H. Platt. New York: S. R. Wells & Co. Price, 10 cents.

Geological History of Cayuga and Seneca Lakes. By C. W. Foote. Ithaca, N. Y.: Norton & Conklin print. Pp. 14.

A Case of Recurring Sarcomatous Tumor. By Thomas Hay, M. D. Philadelphia: Lindsay & Blakiston. Pp. 14. With Lithographic Plates.

Second Stenografik Teecher. Amherst, Mass., U. S. A.: J. B. Smith.

Chemistry of Hydrogen. Also, Reduction of Silver. By A. R. Leeds. New York: Trow & Son print. Pp. 23.

Surgical Anatomy of the Tibio-tarsal Articulation. By Dr. J. A. Wyeth. From *American Journal of Medical Sciences*. Pp. 12.

Directory of the Spiritualism of the Bible. By Susan A. Vandyke. Pp. 4.

Ornithology of the Red River of Texas. By C. A. H. McCauley. Pp. 40. American Insectiv-

erous Mammals. By Elliott Coues. Pp. 22. Bulletin of the United States Entomological Commission. No. 2. Pp. 14. Washington: Government Printing-Office.

The Plants of Wisconsin. By G. D. Swezey. Beloit: *Free Press* print.

POPULAR MISCELLANY.

Scientific Associations for 1877.—The French Association for the Advancement of Science will this year hold its sessions in August, at the city of Havre, under the presidency of Dr. Broca, the eminent archæologist. The Geological Society of Normandy will give an exhibition of the geological and paleontological products of that ancient province.

The annual meeting of the British Association will be held at Plymouth, on August 15th; Prof. Allen Thomson, President. The officers of the Association hope to be supported by the personal assistance and written contributions of philosophers of other countries, and they undertake to make preparation for the reception of the distant friends and associates who may give notice of their intention to be present at the meeting.

The officers of the American Association for the next meeting, which is to be held at Nashville, Tennessee, commencing on Wednesday, August 29th, are Prof. Simon Newcomb, President; Prof. Edward C. Pickering, Vice-President of the Physical Section; Prof. O. C. Marsh, Vice-President Section of Geology and Natural History; Prof. N. T. Lupton, chairman of the Chemical Subsection; Prof. Daniel Wilson, chairman of the Subsection of Anthropology; R. H. Ward, chairman of the Subsection of Microscopy; A. R. Grote, General Secretary; F. W. Putnam, Permanent Secretary; William S. Vaux, Treasurer.

Shad in the Ohio River.—Mr. Spencer F. Baird, of the United States Fish Commission, in a letter to the editor of *Forest and Stream*, states that he has received a few specimens of a genuine white shad, four pounds in weight, taken from the Ohio River at Louisville, Kentucky—a direct result from the efforts made by the commission to stock the western rivers with shad. The letter gives a brief account of the work done by the commission toward introducing the shad into the waters of the Western States, beginning with 1872, when Seth Green planted 30,000 young shad in the Alleghany at Salamanca, New York, and 25,000 in the Mississippi near St. Paul. Later in the same year, the Rev. Mr. Clift placed 200,000 in the Alleghany at Salamanca, and a small number in the Cuyahoga and in the White River at Indianapolis. The same gentleman carried 2,000 young shad as far west as the Platte, at Denver. In 1863 about 160,000 shad were placed in the Greenbriar and New Rivers in West Virginia, and about 55,000 in the Monongahela in Pennsylvania and the Wabash in Indiana. Mr. Baird has been informed that for some considerable time forty to fifty shad have been taken daily at Louisville by a drag seine said not to exceed thirty or forty yards long, and that in the shoaler water of only three or four feet, while the regular steamboat-channel is ten or twelve yards deep and 250 yards wide.

A Remarkable Salt-Bed at Goderich, Ontario.—Dr. T. Sterry Hunt gave, at the late meeting of the Institute of Mining Engineers, an account of the layers of rock-salt in the geological strata of Goderich, Ontario, as developed by a boring recently made. The paper has been published in the *Engineering and Mining Journal*, from which we quote some particulars regarding two of the most important rock-salt beds reached in the course of the boring. A bed of rock-salt of exceptional purity was found at the depth of 1,060 feet, and another bed, not so pure, at the depth of 1,092 feet. Of these, the former is 25 feet thick and the latter 34 feet; they are separated from each other by a layer of less than seven feet of rock, and for practical purposes may be regarded as one. The amount of foreign matter contained in the twenty-five-foot bed is singularly small, being less than a quarter of one per cent. Its remarkable purity is seen on comparing this with the best commercial salts. Thus, Cheshire rock-salt contains of foreign matter 2.67 per cent., and the famous rock-salt of Cardona, Spain, 1.45 per cent. of impurities.

The salts got by evaporation from sea-water and from brines, with which our markets are in great part supplied, contain nearly

as much impurity. "From data gathered by me," says Dr. Hunt, "and published some years since in a 'Report of the Geological Survey of Canada,' it appears that the amount of foreign matters in Turk's Island salt is 2.34; in Saginaw salt, 2.00; in Syracuse solar salt, 1.15; and in the boiled salt from the same locality about 1.50 per cent. Of the salt made at Goderich from the brines pumped from the salt-bearing strata of the region, three samples, analyzed by me in 1871, gave: for coarsely crystalline salt 1.097; flaky medium salt, 1.282; and fine salt, 1.625 per cent. of foreign impurities. The fine salt, which is the least pure, is made by boiling, the others by slower evaporation. The analysis by Dr. Goessmann of another sample of Goderich boiled salt gave 1.50; while the rock-salt from the layer of 10½ feet in Division VIII. of the section [the twenty-five-foot layer mentioned above] contains only 0.234 per cent., or less than one-sixth of the amount of foreign matter found in the boiled salt made from the Goderich brines."

About the English Sparrow.—A spirited but entirely courteous controversy is being carried on in the columns of our contemporary, *Forest and Stream*, about the English sparrow. The principal questions in dispute are whether this bird is useful as a destroyer of noxious insects, worms, and the like, and whether it banishes from its haunts all other species of small birds. The evidence is conflicting. Some of the writers say of the sparrows that they are "exceedingly quarrelsome among themselves," and intolerant of birds of a different species. When a stranger-bird makes his appearance among them, the fury of the whole sparrow community is turned upon him; they chase him hither and thither, giving him no rest until he is banished from the neighborhood. "They" (the sparrows) "let the orchards go to ruin," we are told, "for they will not eat every kind of insect." One writer sums up the case against the sparrows thus: 1. They have no personal attractions except their tameness; 2. They are practically useless; they may have been useful on their first arrival from Europe, but they are too much pampered to be so now; 3. They destroy fruit-blossoms; 4. They are often quarrelsome, and sometimes drive away useful birds. On the other hand, we are told that the sparrows destroy immense numbers of larvæ, especially during the winter; that they are *not* hostile to other birds; that they do not destroy fruit-germs. A writer who lives in Tenafly, New Jersey, says: "We have a few sparrows in the yard, and find their presence makes very little difference with the other birds. We have sixteen varieties of birds in the yard at this writing, viz., brown thrush, robins, catbirds, orioles, wood-robin, bluebirds, phœbe-bird, cuckoo, kingbird, and the rest warblers of different kinds. We find the most quarrelsome to be the kingbird and black oriole. These last are chasing almost everything that crosses their path."

Hygiene of the Eyes.—A series of questions touching the care of the eyes were recently submitted to Dr. E. G. Loring, Jr., by the Medico-Legal Society of New York. Dr. Loring replied in a paper which has since been published in the *Medical Record*. To the first question—namely, whether bad air has any direct effect on the sight?—the author replies that vitiated air has a specially irritating influence on the mucous membrane of the eye; and that bad air, as a primal cause, may set in train morbid processes which not only will affect the working capacity and integrity of the organ, but may even lead to its total destruction. The second question was, whether size and quality of type may cause disease of the eye? According to Dr. Loring, the smallest print which a normal eye can readily recognize at a distance of one foot is about $\frac{1}{10}$ inch, and at eighteen inches' distance about $\frac{1}{14}$ inch. The normal eye should never be subjected for any length of time to a type smaller than twice this size, or $\frac{1}{18}$ inch, and it would be better, after middle-life, to employ a type even a little larger than this; but the employment of spectacles removes in a great degree the necessity of a larger type with advancing years. The finer the type, the closer the book has to be held to the eye, and the greater the demand on the focalizing power and the muscles that bring both eyes to bear at once upon the print. On the other hand, too coarse type is wearisome to the

eye, requiring more exertion of the muscles that govern the movements of the eye. The distance between the lines should be about one-eighth inch; nearer than this is apt to be confusing, farther apart is also confusing. Heavy-faced type is preferable to light-faced. An almost imperceptible yellow tint in the paper, "natural tint," is very desirable; pure white paper, especially if it has a metallic lustre with bluish tinge, should not be employed. The paper should be thick enough not to be transparent, should have a close, fine texture, and be free from sponginess. To the third question—whether too long and constrained attention to one object, without rest or variety, will cause eye-disease?—Dr. Loring replies affirmatively, and assigns the physiological reasons. Finally, he was asked whether the angle at which light strikes the eye is important? He replies that the light should not come directly in front; neither should it come from directly behind. It should not come from the right side, because, in writing, the shadow of the hand falls across the page; and a moving shadow over a lighted surface not only reduces the quantity of light and leads to a stooping position, but it is also more annoying to the eye than a uniform reduction in the illumination of even a greater degree. The best direction for the light to come is from the left-hand side, and from rather above than below the level of the hand.

High Temperatures and Bowel-Complaints.—Dr. N. S. Davis, in a "Report on Clinical and Meteorological Records" communicated to the American Medical Association, an abstract of which we find in the *Medical Record*, reaches the conclusion that the bowel affections, so characteristic of this temperate climate, begin invariably with the first week of continuous high temperature, and that every subsequent occurrence of several days and nights of continuous high temperature causes new attacks to be increased in number throughout the month of July, less in August, and still less in September; that it is not simply the extreme of heat, but its duration, which determines the number of attacks; that this continuous high heat, to be efficient in producing these affections, must follow a protracted season of cold; and that, if we compare these deductions directly with statistics of mortality, we shall find them to conform in every particular in that the high rate of mortality follows exactly the same line. That fact was regarded as one of great importance in connection with sanitary measures which were to be adopted for the protection of life in infants; preventive measures must strike with the first week of consecutive high temperature. These conclusions were corroborated by quotations from mortality-tables.

Manurial Value of Spent Tan and Sawdust.—From careful analyses of spent tans and dyewoods and other similar waste materials, Prof. F. H. Storer, of the Bussy Institution, reaches the general conclusion that they contain but a very small proportion of fertilizing substances, and that practically, whether they be fresh or rotten, they have very little value as manure. Of fresh sawdust, even that from hard woods, he says that it can hardly be considered an economical manure; it is far inferior, for compost, to peat. But, curiously enough, the chemical evidence goes to show that it is for feeding animals rather than for feeding plants that sawdust might be put to use. Fresh sawdust, even that of pine-trees, can be used with advantage as fodder in times of dearth. Twigs and leaves, as the clippings of vines and hedges, or bushes mown in pastures, are undoubtedly valuable both as manure and forage. Autumn leaves and the rakings of woodland, which consist for the most part of leaves that have not only fallen, but have been bleached by rains, may be classed as somewhat inferior to straw.

Wearing Qualities of Aluminium.—The comparative resistance of aluminium to change of color and wear, when brought into daily use, has been made the subject of observation by Dr. C. Winkler, of Freiberg, who finds, according to the *Polytechnic Review*, that it is inferior to silver in retaining color and lustre, being about on a par with German-silver in these respects; while it wears away more rapidly than silver, but less so than German-silver. Spoons made of all three materials, each having exactly the

same weight, were used a year under precisely similar conditions, being placed in the same soups, sauces, sour salads, etc., and exposed alike to hot, acid, and alkaline solutions, and subjected to similar methods of cleaning. The aluminium turned to a dead bluish-gray color, and lost its lustre; the German-silver changed to a grayish-yellow; the silver lost only in color, retaining its lustre. Weighed at the end of the year, the silver spoon had lost 0.403 per cent., the aluminium spoon 0.630 per cent., and the German-silver spoon 1.006 per cent. For small coins, Dr. Winkler thinks that aluminium is to be preferred to either nickel or silver alloys.

Is Insanity on the Increase?—Do the conditions of human life, as they exist in modern civilized countries, tend to an increase of insanity? A glance at the statistics of the insane for any given country would seem to require an affirmative answer to this question. For instance, the ratio of insane persons in England in the year 1859 was 18.67 to 100,000 persons; in 1865 it was 21.73; in 1870, 24.31; in 1876, 26.78. In other words, there is now one insane person to 375 of the population, while in 1859 the proportion was about one in 540. But, as is shown by Dr. Henry Maudsley, in the *Journal of Mental Science*, the increase is apparent only; more insane persons are *registered* now than formerly. Again, the establishment of numerous asylums, and the better care bestowed on patients, have had the effect of prolonging the lives of the insane; this, too, will in part account for the higher proportion of insane shown by the statistics. The question is incidentally raised by Dr. Maudsley, whether we *cure* more insane persons nowadays, when we treat them well, than our uninstructed forefathers cured when they treated them ill. "There is," he replies, "no evidence that we do." Here the statistics *would seem* to show that, under the old system, there was a higher percentage of recoveries. "Yet, it would be wrong," remarks the author, "to attribute the lower percentage of recoveries to the ill-success of our present mode of dealing with insanity; it is, no doubt, owing in great part, if not entirely, to the greater proportion of chronic and incurable cases among those who have been admitted during the last twenty-five years. Formerly, acute and violent cases only were sent to asylums, and they would yield a larger percentage of recoveries, as well, probably, as a larger percentage of deaths. Of the admissions fewer recover and fewer die each year now than then, the result being the steady accumulation of a residue of chronic and incurable insanity beyond what occurred then. It is a question," he adds, "deserving attention, whether the present practice of crowding the insane of all sorts into large asylums, where the interests of life are extinguished, and where anything like individual treatment is wellnigh impracticable, is so much superior to the old system in effecting recoveries as some persons imagine."

The Rocky-Mountain Locust in Manitoba.—The following notes on the appearance and migration of the locust in Manitoba and the Northwest in the summer of 1875 are taken from a notice, in the *American Journal of Science*, of a paper on that subject by George M. Dawson. In the year just mentioned the hatching of locusts began in Manitoba on May 7th, and on May 15th it was general. The movement began in July, and was most general during the latter half of that month and the early part of August. The direction was southeast or south. Other swarms of locusts came from the south across the forty-ninth parallel, with a wide front stretching from the ninety-eighth to the one-hundred-and-eighth meridian; these arrived before the Manitoba broods were mature. These were the extreme northern part of the army, going northward and northwestward from the States ravaged in the fall of 1874. Mr. Dawson thinks that the planting of belts of woodland would in time effect a general and permanent abatement of the grasshopper-plague, since they usually avoid such belts. Their journey southward was regardless of the direction from which their parents had come the preceding year; and those of Nebraska, Missouri, Kansas, and Texas, flew northward and northwestward, returning on the course of their parents, who had flown southeastward from that quarter. The normal direction of flight is

toward the hatching-grounds of their parents, so that two years seem to be required to complete the migration cycle. The methods of prevention proposed are the cultivation and preservation of forest-trees; the protection of the prairie-grass till the appropriate time for destroying the young insects by fire; and the protection of insect-catching birds.

A New Wheat-Fungus in California.—Early in March of the present year the young wheat in certain districts of California began to exhibit on its expanded leaves yellowish-white patches of fungous growth. This peculiar species of "rust" or "mildew" appears to be new to California, and has been recognized by Mr. H. W. Harkness, of the San Francisco Microscopical Society, as the *Erysiphe graminis* of De Candolle. According to Mr. Harkness, the fungus appears on the expanded leaves in felt-like patches, from one-sixteenth to one-half inch in length, following the longest diameter of the leaf equally on both sides. It adheres with great tenacity, though, on examining sections of the leaf and fungus, no suckers are apparent. The leaf, at a short distance from the culm, soon turns brown and dries. In the earlier stages the mycelium is observed creeping over the surface, its filaments overlying one another until it forms a felted mass. To what extent the wheat will be damaged, it is as yet impossible to say. Adhering, as it does, closely to the plant, it doubtless appropriates the juices needed for maturing the grain, at the same time excluding air and sunlight from the tissues. Its visible effect is a weakening of the stalk, thus favoring decay.

A New Measure of Geological Time.—The amount of solid matter abraded from the land and carried to the sea as sediment, or in suspension, has often been estimated by geologists, and the importance of this suspended matter as an agent of geological changes has been fully recognized. But less attention has been bestowed upon the soluble matter washed out of the earth by every fall of rain and added to the waters of the ocean. This subject has been studied by Mr. T. Mellard Reade, whose results, as set forth in his presidential address to the Liverpool Geological Society, we find summarized in the *Nineteenth Century* as follows: The author's first problem was to estimate the total quantity of solid material removed in the course of one year, by the solvent action of rain, from the entire surface of England and Wales, supposing the mean rainfall to be thirty-two inches. It is worthy of note that the variation of rainfall in different parts does not affect the quantity of dissolved matter to anything like the extent that might have been anticipated. True, the hilly districts of the west, in Cumberland, Wales, Cornwall, and Devon, intercept a large quantity of rain; but, then, these collecting-grounds are composed of old rocks, ranging from Cambrian to Carboniferous; and such rocks are, to a great extent, insoluble. On the other hand, in the southern and eastern counties the rainfall is much less than in the west; but, then, the rocks belong generally to Secondary and Tertiary formations, and are tolerably soft and soluble. A kind of compensation is thus established, the total quantity of solid matter carried off in solution in a given time being much the same in one river as in another. Roughly speaking, it may be said that where the rainfall is greatest the solubility is least; where the rainfall is least the solubility is greatest. It is needless to follow the details of the calculation by which the author is finally led to the conclusion that about 8,370,630 tons of solids are annually removed in solution by the rivers of England and Wales. Distributing the denudation equally over the country, the total area being 58,300 square miles, we obtain a general lowering of the surface to the extent of .000077 of a foot in a single year; in other words, it would require 12,978 years to reduce the surface of England and Wales by one foot through the solvent action of rain alone. Fewer data exist for extending this interesting inquiry to the Continent of Europe, and fewer still when we pass to other parts of the world. But, making the best of available data, and proceeding on the principle that "Nature, on the whole, averages the results," Mr. Reade feels justified in assuming provisionally that about one hundred tons of rocky matter will be dissolved by

rain from every English square mile of the solid surface of the earth in the course of a year. All this dissolved matter, however far it may be transported by rivers, ultimately runs down into the sea. If, then, as commonly supposed, the sea contains only what has been washed out of the land, the results previously attained may help us to form some crude idea of the length of time which has been needed to give the ocean its present composition. Not to be irksome, we may pass over an array of figures and a number of provisional assumptions, in order to reach conclusions of general interest. These conclusions are, that it would take, in round numbers, 20,000,000 years to accumulate the quantity of sulphates of lime and magnesia contained in the vast bulk of the ocean, but only 480,000 years to renew the carbonates of lime and magnesia; with reference, however, to the latter constituents, it must be borne in mind that a vast quantity of carbonate of lime is constantly being removed from sea-water for the supply of the hard parts of shell-fish, crustaceans, corals, and other marine animals, and consequently the amount calculated as present in the ocean is far from indicating the total quantity which is poured into it. But what are we to say of the chlorides, especially the chloride of sodium, which is the prime constituent of sea-water? The ocean contains so much of this salt, and the rivers usually so little, that we are driven to conclude from the author's calculations that it would take 200,000,000 years to renew the chlorides in the ocean!

Geological Changes in Colorado.—It is noted as an interesting fact by Dr. A. C. Peale, in the *American Journal of Science*, that Colorado, which now possesses the highest mass of mountains in the United States, and whose mean elevation is higher than that of any other State or Territory, was also one of the highest areas of the North American Continent in Palæozoic time. In very early time in Colorado there was archæan land rising above the Palæozoic sea. As the Carboniferous age progressed, this land diminished by encroachment of the sea, due to subsidence of the land. This subsidence continued through Triassic, Jurassic, and Cretaceous time, into the early Tertiary. At the close of the Lignitic there was a physical break, followed by a subsidence (at least locally) and subsequently by elevation, after the deposition of the Miocene strata. The elevation of the Rocky Mountains, as we now see them in Colorado, is the result of an elevation commencing in early Tertiary time and continuing through the period, accelerated perhaps at the close of the Lignitic, and the deposition of at least Lower Miocene strata. This elevation is probably still going on.

The Building System of Philadelphia.—A paper on "A Building System for Great Cities," published in the *Penn Monthly*, contains an account of what may be called the Philadelphia system, of separate houses for families of very moderate means—artisans, and even laborers. There are three primary forms of houses, viz., the two-story four-roomed house, the two-story six-roomed house, and the three-story eight-roomed house, the value of which is respectively $1,200 to $2,500, $2,500 to $3,800, and $3,000 to $5,000. They are always of brick, erected on stone-walled cellars not less than seven feet deep, fourteen by twenty-eight feet for the smallest houses, fourteen to sixteen by forty-two to forty-five feet for the six-roomed and the eight-roomed houses. All these are built in contiguous rows or blocks with a common wall between them. Since the inauguration of the system, which scarcely dates before the year 1862, building has made rapid progress. In 1867 it began to be specially active, and since that time an average of 4,500 houses yearly has been erected, of which 2,500 were two-story and 2,000 three-story. The writer of the paper in the *Penn Monthly* has learned, from a personal inspection of a district near the southern border of the city of Philadelphia, that three-fourths of the dwellings that have been erected two years or more are owned by those who live in them. In a space less than a mile square, and containing 4,000 dwellings, the proportion of vacant houses was less than two per cent. Certainly more than one-half of these dwellings were owned by their occupants, and often entire blocks of thirty or forty houses would show over ninety per cent. so owned.

Are the Salts of Copper poisonous?—Dr. Burcq, M. Galippe, and others, having in communications addressed to the Paris Academy of Sciences asserted that copper is not poisonous after the manner of lead, and that it may be absorbed for a long time without injurious consequences, Dr. E. Decaisne has submitted to the same Academy the results of observations made by himself, from which it would appear that the reverse is the fact. We present a synopsis of Dr. Decaisne's paper, which we find in *La Nature*. He states that in 1864 he published a memoir entitled "A Medical Study on Absinthe-Drinkers," in which it was shown that a great many of the cheaper qualities of absinthe contain sulphate of copper, and that, of a hundred and fifty absinthe-drinkers observed by him, a certain number gave clear evidence of copper-poisoning. Fifteen samples of absinthe, purchased at wine-shops in Paris, all contained sulphate of copper in varying proportions: three of the samples contained it in the proportion of twenty-five centigrammes to the litre. Indeed, some of the distillers frankly admitted that they used sulphate of copper to color the absinthe. M. Decaisne cited a recent case of poisoning by acetate of copper, that of a young man of twenty-three, who showed all the symptoms of acute poisoning by copper salts, after having drunk some "eau de vie de marc," an inferior quality of brandy. Analysis of a sample of this brandy showed it to contain 1.164 gramme of acetate of copper to the litre. The liquor had been distilled in an apparatus that had lain unused for a year, and which had become filled with acetate of copper. French statistics show that sulphate and acetate of lead rank third among substances employed in criminal poisoning.

NOTES.

Mr. Jabez Hogg, the eminent English microscopist, in a recent paper calls attention to certain "errors of interpretation" to which microscopists are liable in examining the scales of insects and other minute objects. Some such "errors of interpretation" were pointed out by Mr. John Michels in the Monthly two years ago, but his statements were at the time called in question by microscopists in various portions of this country. Mr. Hogg himself, when these errors were first pointed out in the London Microscopical Society by Dr. Piggott, expressed the opinion that the latter was laboring under a mistake. Later, however, he was convinced of the correctness of Piggott's views, and now confirms them with his own observations.

A pressure of forty to one hundred and twenty atmospheres has been found by Quincke to be incapable of forcing a perceptible quantity of carbonic-acid or hydrogen gas through a glass wall 1.5 millimetre in thickness, during a period of fifteen years.

A monument to Liebig was unveiled at Darmstadt, his native town, on May 12th, the seventy-fourth anniversary of his birth.

Died, in Berlin, on March 29th, Alexander Braun, Professor of Botany in the University of Berlin, aged seventy-two years. In a brief notice of his life Professor Asa Gray says: "His influence as a teacher is said to have been great; as an investigator, he stood in the first rank among the botanists of our time; as a man, his simple, earnest, and transparently truthful character won the admiration and love of all who knew him." With Braun's memoirs on the "Arrangement of the Scales of Pine-Cones, etc." (1830), began the present knowledge of phyllotaxis. Other noteworthy memoirs by this author are that on "Rejuvenescence in Nature," and "The Vegetable Individual in its Relation to Species," both of which have been translated into English.

The residual charcoal, after lixiviation of destructively distilled sea-weed, possesses an extraordinary power of absorption and deodorization. According to Mr. E. C. C. Stanford, its composition is about midway between that from wood and that from bone, in the proportion of carbon; but it is more nearly like the latter, from which it differs in containing more carbon and carbonates of calcium and magnesium, and less phosphates. It can be obtained at one-fourth the price of any other charcoal.

Mention is made, in *Land and Water*, of a singular hybrid, the progeny of a barnyard cock and a common duck. The body of the hybrid is like that of a duck, but the feet, which have three front claws and a rudimentary back one, are not webbed, and the upper mandible is that of a fowl, extending only half the length of the lower, which is that of a duck, the singular formation causing great difficulty in feeding.

A writer in the *American Naturalist* cites the following instance of carnivorous habits in the red-headed woodpecker: In the summer of 1876 a man in Humboldt County, Iowa, raised a large number of black

Cayuga ducks. While the birds were still very young, many of them disappeared, and the bodies of several were found with the brains picked out. On watching carefully, a red-headed woodpecker was caught in the act. He killed the tender duckling with a single blow on the head, and then picked out and ate the brains.

THE "Transactions" of the American Society of Civil Engineers for May contains an article on "Approximate Determination of Stresses in the Eye-Bar Head," by W. H. Burr; minutes of meetings; an interesting letter written by General Philip Schuyler in 1799, giving his opinion of a plan proposed by Dr. Brown for supplying this city with water from the Bronx River; and a list of new books on engineering and technology, besides other matters of interest to engineers.

MR. MCNAB, of the Edinburgh Botanical Society, states that the past spring in Scotland was more backward than any other during the last twenty-eight years.

HAVING measured the red blood-corpuscles of men belonging to fourteen different races or nationalities, Dr. Richardson, of Philadelphia, found the average diameter to be $\frac{1}{3333}$ of an inch, the maximum diameter being $\frac{1}{3077}$, and the minimum $\frac{1}{4000}$.

THE "hard glass" manufactured by Siemens, of Dresden, by means of hydraulic pressure, is said to be stronger than Bastie's glass, in the proportion of five to three. Its fracture, according to the *English Mechanic*, is fibrous, not crystalline. Besides being stronger, it is also cheaper than Bastie's "tempered" glass; and, unlike the latter, sheets of the Dresden glass can be cut to any size with the diamond.

THE number of blind persons per 100,000 of the population of Bavaria is 52; of the United States, 52; Prussia, 58; Belgium, 66; Switzerland, 77; Sweden, 81; France, 84; Norway, 184. The number of insane, cretins, and idiots, is, in Bavaria, 110 per 100,000; in the United States, 160; Scotland, 185; France, 238; Switzerland, 300; Würtemberg, 312; Norway, 340. Of deaf-mutes the United States have 45 per 100,000; Belgium, 46; Bavaria, 58; France, 58; Saxony, 60; Switzerland, 245.

TRADE, commerce, is usually considered one of the chief influences favoring civilization; yet, according to Mr. James Irvine, it has the contrary effect in Africa. Every native is a trader from the day of his birth, and the cultivation of the soil is utterly neglected. The buying and selling of palm-oil, palm-kernels, and a few minor products, give them really all they require, and they cannot be stimulated to further exertion.

LANGEROY, in a communication to the Paris Academy of Sciences, calls attention to the antiseptic properties of bichromate of potassa. According to him, one per cent. of the bichromate in water absolutely prevents putrefaction in all animal and vegetable substances. After meat has stood in the solution for a few months it resembles gutta-percha, and medals have been struck from it; but it becomes poisonous, and even dogs refuse to eat it. This antiseptic will doubtless be of great use for the preservation of natural-history specimens.

A SIMPLE and ingenious contrivance for drawing liquids from carboys is described in *La Nature*. It consists of two tubes passing into the carboy through the stopper, one of the tubes serving as a siphon, and the other as a means of increasing the air-pressure over the liquid. At its outer extremity the siphon has attached to it a short section of rubber or gutta-percha tube, which may be compressed by a clamp. To fill the siphon, a person blows through the short tube, with the clamp relaxed. When sufficient liquid is drawn off, the clamp is allowed to compress the walls of the elastic tube, stopping the flow.

IN a late report on the origin of the skin-disease known as Delhi boil, or, as it has been lately named from its wide distribution in the East, Oriental sore, Drs. Lewis and Cunningham reject the view that the affection is attributable to parasitic agency. From extended observations in widely-separated districts they are led to ascribe the disease to the use of well-waters that contain a large quantity of salts, and are extremely hard. In Egypt, Asia Minor, and Syria, where the sore prevails, the well-waters are notoriously brackish, agreeing in this with many stations in India, where the disease is also prevalent.

DR. C. A. BRESSA, deceased in 1835, bequeathed all his property to the Turin Academy of Sciences, the net interest to be given every two years as a prize for the best work done, during the previous four years, in physics, natural history, chemistry, physiology, pathology, geology, history, geography, or statistics. The fund is now available, and the first award will be made two years hence. The competition will be open to the whole world, and the prize will amount to about $2,500.

MOLES render to the farmer and gardener very considerable service at little or no cost—the damage they do being more than compensated by the destruction of worms and grubs. When they have eaten all the grubs and worms in a certain place, they emigrate to another, and there repeat their gratuitous work.

SIMON NEWCOMB.